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THE
MODERN TREATMENT
OF WOUNDS.

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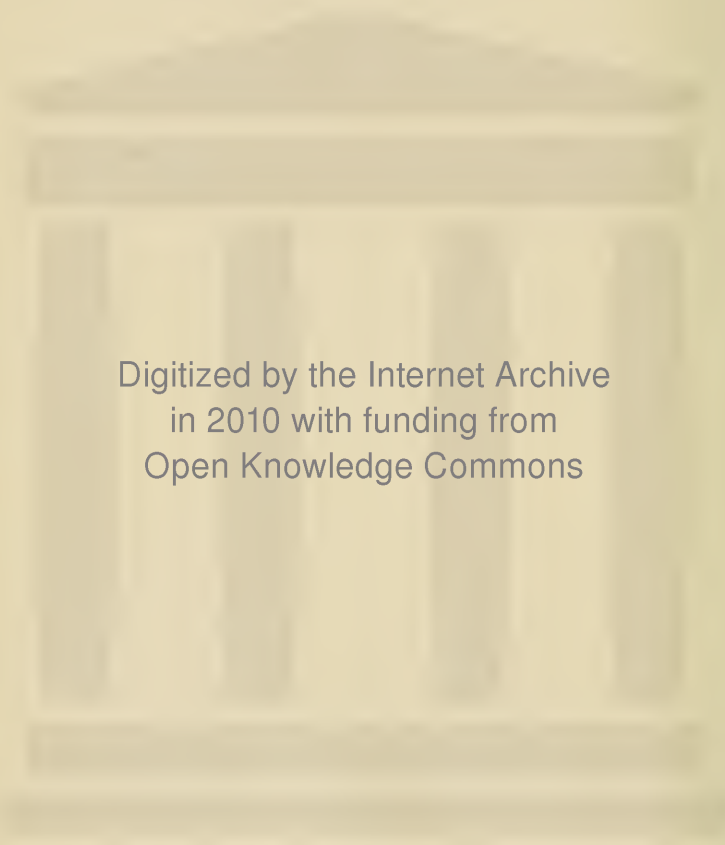
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THE Modern Treatment of Wounds

BY

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Sub

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To
JOHN E. SUMMERS, M. D.,
COLONEL AND SURGEON U. S. ARMY (RETIRED).
A
SMALL TOKEN OF MY AFFECTION
AS A SON.

Charles Eluey
11/26/40

PREFACE.

In the preparation of this little book I have tried to indicate means towards ends.

An attempt has been made to keep within the subject title of the book, yet it has been thought necessary occasionally to discuss pathology and diagnosis in order to lead up to a rational practice. If at times some statements appear dogmatic, they will, I hope, be pardoned, because they have the merit at least of being based upon a liberal personal experience, both as a teacher and practitioner of surgery.

November 1, 1899.

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ERRATUM.

Page 52, after *Kidney*.—(1.) . . . “a right-sided abdominal section” should read “a right- or left-sided abdominal section.”

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MODERN TREATMENT OF WOUNDS.

CHAPTER I.

BACTERIA AND WOUNDS.

Effect of Bacteria on Wound Healing.—The most important principles underlying the treatment of wounds are based upon a clinical comprehension of bacteriology, however desirable it may be for the practitioner to have a combined laboratory and bedside knowledge. It should be well understood that the introduction of micro-organisms into wounds is responsible for most ill effects, except those due directly to the nature of the wound. This introduction of micro-organisms into wounds can, in those inflicted by the surgeon, be prevented, and in the treatment of all wounds means are at command to nullify or modify any serious results caused by micro-organisms.

The marvelous decrease in death rate from wounds, either surgically or accidentally inflicted, and the limitations of the spread of infectious diseases, are all the result of the work of laborers in the field of bacteriology and experimental medicine. Among the numerous germs we need only consider the chief ones acting as etiological factors of surgical wound diseases.

Divisions of Micro-organisms.—There are three chief divisions of micro-organisms which we have to bear in mind: 1. *Micrococci*, which are cells, either round or oval in form, and may be found singly, in chains, or in masses. 2. The *Bacilli*, which are rod-shaped cells, found singly, in chains, or swarms; their length is more than twice their breadth. 3. *Bacteria*, which may be rod-shaped, but when so their length does not more than equal twice their breadth; they are also oval in form, and are found single, in chains, or masses. All the different forms of micro-organisms are quite commonly spoken of under the general

heading of *Bacteria*. They all have the property of a marvelous reproduction, millions being generated from a single bacillus in a few hours. All bacteria are of vegetable origin.

Many bacteria are capable of producing irritation and inflammation of wounds. They act either directly or by chemical products formed as a result of their known peptonizing action upon the albuminous substances. These are poured out upon the wound area and are intended by nature as reparative material. This peptonizing action results in the production of what is called pus. The so-called pyogenic (pus-forming) organisms are chiefly responsible for this peptonizing action, confined at first to the surface of the wound, but later penetrating into the tissues themselves. In some cases either bacteria or their chemical products penetrate into the deeper tissues of the wound or enter the general circulation, producing more extensive local irritation or severe intoxication. Ordinarily, the only organisms (cocci) which cause the formation of pus are the staphylococcus pyogenes aureus and albus (which form in clusters) and another much more dangerous organism, the streptococcus pyogenes (cocci which form in chains). The Tetanus Bacillus is also of importance. When, as is a common occurrence, wounds which have been exposed to micro-organism infection heal without the formation of pus we know that either something prevented the peptonizing action of these organisms upon the albuminous elements of the wound secretion (exudate), or that nature was able in the struggle for supremacy (the battle between the organisms and the vital elements of the body) to conquer. Bacteria usually grow rapidly at a temperature ranging from 75° to 104° F. Those which grow at the lower temperature tend to cause a putrefactive condition in the wound secretion; those which grow most rapidly at the higher temperatures are commonly those producing diseases of a more or less typical kind and are called *pathogenic*. The history of epidemic diseases has proven that severe cold does not kill many bacteria, the disease reappearing

upon the return of the warm season. Dry heat is not a reliable agent to kill micro-organisms, but moist heat, boiling water or steam, because of its greater penetration, will kill every variety of bacteria. Many chemicals have the power of killing bacteria and at the same time, when used judiciously, do not act in a harmful way upon wounds. A utilization of our knowledge of the action of both heat and these chemicals upon all micro-organisms is the basis upon which is built the modern treatment of wounds,—the Aseptic and Antiseptic Methods.

Aseptic Surgery.—By Aseptic Surgery is understood the employment of known means (chemical and mechanical) in the sterilization of the hands of operators and assistants, instruments, and all dressings and material used. The sterilization of the tissue area of the wound about to be made must also be complete and the wound protected from contamination from all sources. After the incision or puncture no chemical agents having irritating or sterilizing properties are allowed to come in contact with the raw surfaces. The dressings applied must be sterile, but contain no chemical.

Antiseptic Surgery.—Antiseptic Surgery is the embodiment of all the details of Aseptic Surgery and in addition the use of chemicals upon the wound surfaces during the progress and after the completion of the operation. The idea being to inhibit by the use of chemicals the possible ravages of bacteria which may have gained entrance into the wound because of a faulty technique or preparation upon the part of those concerned in the carrying out of the operation. With few exceptions all wounds not made by the surgeon demand antiseptic treatment. The employment of certain chemicals (antiseptics) is intended to kill or to weaken the power of any germs which possibly have infected a fresh wound. If suppuration is already established these chemicals stop fermentation and putrefaction, and protect the patient from the more severe local and constitutional effects of wound infection.

Drainage.—Another cardinal principal of antiseptic surgery is to provide for drainage in wounds where there is suppuration, and to so care for these wounds that all discharges will be received into dressings impregnated with antiseptics which will prevent putrefaction of discharges. Antiseptic dressings are also employed to keep germs from gaining access to a wound after the completion of an operation, or to prevent reinfection of a disinfected wound.

CHAPTER II.

PREPARATORY SURGICAL TECHNIQUE.

Disinfection of the Hands and Forearms of the Surgeon.
—This must be both mechanical and chemical. The surgeon and assistant should thoroughly scrub their hands and forearms with warm water and soap, being particularly careful to remove all dirt and macerated epithelium from around and under the finger nails, using the scrub brush and nail cleaner carefully. Both the brush and nail cleaner ought to be boiled in ordinary water or immersed in a 5 per cent. solution of carbolic acid in water before using. After this mechanical cleansing, wash the hands and forearms in sterilized warm water, and in addition have a little alcohol poured on the hands. Then immerse the hands and forearms in a 1-1,000 solution of bichloride. Green soap is preferable to other soaps, and especially is this so when a little corn meal has been added to it. Green (soft) soap and turpentine, with liberal quantities of ordinary warm water, a good nail brush and nail cleaner can render the hands proof against infecting a wound. Because of its efficacy and the smooth condition in which the hands are left the following way of sterilizing the hands is practiced by many: After thoroughly washing the hands and forearms with soap and water and a brush and using the nail cleaner, a tablespoonful of chlorinated lime is placed in the palms of the hands and to this is added an equal quantity of washing soda (carbonate of soda). When sufficiently moistened and mixed by rubbing the hands together the mixture is made to come in contact with all parts of the forearms and hands, especially around the nails. Hot sterile water is used to wash away the mixture. Any method of sterilization of the hands must be conscientiously carried out, and the simple ones given are as reliable and more easy of accomplishment than many others. The practical and ideal way of protecting a wound against infection is the

habitual use of sterilized rubber gloves by everyone taking part in a surgical operation. Of this we will speak later.

Sterilization of Ligatures and Suture Materials.—Silk which has been boiled for one-half hour before an operation is practically safe, but it may be made and preserved sterile by boiling in water for one hour and then placing it in a 5 per cent. carbolic acid solution, made by adding the acid to freshly boiled water.

Silkworm Gut and Silver Wire.—These are best sterilized by boiling in water from fifteen minutes to half an hour immediately before using. Some surgeons, however, consider the immersion of these materials in a 5 per cent. solution of carbolic acid in water sufficient for their practical sterilization.

Catgut.—The most modern method for the sterilization of catgut is by means of formalin, the advantage being that the gut is rendered less soluble in the tissues and therefore more reliable. After the gut has been impregnated with formalin it can also be subjected to boiling in water without losing its tensile strength. The gut is first immersed in a solution of formalin of from 2 to 4 per cent., according to its size, and allowed to remain in the solution for a period of from twelve to forty-eight hours. The formalin is then removed by soaking in clear water for twelve hours, the water being changed frequently. It is then boiled in water for fifteen minutes, after which it is transferred to a vessel containing alcohol, where it may be kept until required for use. From 2 to 4 per cent. of carbolic acid may be added to the alcohol, as it makes the gut more firm. It should be placed in plain alcohol for about a half hour before using. Before boiling the gut, it should be wound tightly on a glass spool or dry cork, the object being to keep the gut in a high state of tension. The cork has some advantages over the glass rod, in that it expands by the absorption of the water, and thus increases the tension on the gut.

One of the best methods for the sterilization of catgut *without* the use of formalin is the following: A

reliable article of catgut in different sizes should be wound and twisted into loose rings about three-fourths of an inch in diameter. These are placed in a 1-1,000 solution of bichloride ether, remaining for twenty-four hours. The ether abstracts the fat from the gut. It is then removed and placed in bichloride alcohol, 1-1,000, for twenty-four hours. The gut is then put into alcohol, and the bottle, a wide mouthed one, lightly stopped with sterile absorbent cotton, placed in a vessel of boiling water and boiled for fifteen minutes. This boiling is repeated for three successive days, adding sufficient alcohol when too much evaporates. After the third boiling the gut is placed in absolute alcohol and is ready for use. When required it must be removed from the bottle with sterilized forceps. If thought best to chromicise this catgut, in order to add to its strength and resistance to rapid absorption, it is placed into this solution: Chromic acid 1 part; carbolic acid 200 parts; sterile water 2,000 parts. After twenty-four hours the gut is removed and placed in absolute alcohol. Bichloride of mercury should not be added to the preserving alcohol, as it renders the gut too brittle.

Catgut as Prepared and Sold by Supply Houses.—It is becoming the custom among surgeons, and, in fact, of some hospitals of best repute, to buy catgut all ready prepared. The only articles, however, which are reliable are those which are prepared in hermetically sealed glass tubes, requiring the breaking of these for their use. Complex arrangements furnished by the supply houses which admit of catgut and silk being pulled out in shorter or greater lengths are dangerous and should be avoided, as the material remaining in the bottles may become contaminated from without. For the ordinary minor surgery of the office and private family, needles of different sizes and curves, already threaded with silk, silkworm gut, or catgut, sterilized and sealed in glass tubes, as furnished by the supply houses, are convenient and thoroughly reliable.

Kangaroo Tendon.—For buried absorbable sutures in certain operations, especially for the radical cure of hernia, there is perhaps no material equal to kangaroo tendon. For its use we are indebted to Marcy, of Boston, and from him the best article, either sterilized or non-sterilized, is to be procured. The sterilized article is expensive. However, a large bundle of the tendons can be bought for a moderate sum and sterilized at home. The following is the method used and advised by Marcy: The tendons are first soaked in a solution of 1-1,000 of bichloride of mercury in water until supple. They are then carefully separated and dried between sterilized towels. After assorting them into small bundles, they are chromicised by placing them in a 1-20 watery solution of carbolic acid to which has been added 1-4,000 part of purified chromic acid. The tendons must be immersed in the solution immediately upon the preparation of the fluid, since otherwise in a short period the chromic acid is thrown down as a sedimentary deposit.

The process of chromicization goes on more or less rapidly, dependent upon heat, exposure to sunlight, the quantity of material manipulated, and requires careful watching, since, if too rapidly effected or permitted to remain too long in the solution, the tendons may be easily ruined. When properly chromicised, the tendons should be of a dark golden color. When taken from the chromicizing fluid the tendons are best dried in the sunshine between sterilized towels, and should be immediately put in a carbolic oil, the whole process carefully conducted under aseptic conditions, the bottles securely corked and sealed. When wanted for use, the tendon is carefully taken from the bottle, soaked in a mercuric solution until supple, and then arranged in parallel strands, wrapped in a folded towel saturated with a 1 to 1,000 mercuric solution, the ends of the tendons exposed so that they may be withdrawn one at a time as selected. If more convenient, they can remain immersed in a dish of bichloride solution during the operation and selected as required. The amount of the bichloride contained

in the suture does no harm to the structures in which it is buried; it is advantageous rather than otherwise. Many surgeons deem it unnecessary to do more than place the tendons into bichloride ether, 1 to 1,000, for twelve hours, and then remove them and place them, strung out, into a long narrow bottle filled with alcohol. For use they are removed as required and put into a 1-40 solution of carbolic acid in water.

Dressings and Instruments.—All materials used for covering and protecting wounds should be prepared and handled with the most scrupulous care. Dry sterile dressings are best used to protect wounds either aseptically or antiseptically made, from which little or no discharge is expected. All other wounds are more safely handled by being covered with dressings which are moist with some antiseptic fluid. If a dry dressing is employed to cover a wound which may possibly have become infected or is discharging pus at the time the dressing is applied, there will *always* be a greater or less accumulation of discharges under the dressing, just as pus is retained under a scab. Such a condition cannot help but interfere with the reparative process. Gauze (cheese-cloth) is the material usually used next the wound surface. Absorbent cotton is placed over the gauze, and over all a bandage or binder. One or two layers of gauze or cotton may be fastened over a dry wound by means of sterile collodion applied to the borders of the dressing. Gauze may be impregnated with some antiseptic material, as iodoform or boracic acid, or either these or some other drug in powder form can be dusted upon the wound before the gauze is applied.

Cheese-cloth may be bought from the dry goods houses at from $2\frac{1}{2}$ to 4 cents per yard. To prepare for use, boil for fifteen minutes in a solution of carbonate of soda, 1 dram to 1 quart of water, and then for one-half hour in clear water; cut into sized pieces desired and put into an Arnold or Boeckmann sterilizer for one hour before using. It is desirable in transporting gauze after sterilization to put it in some sterilized glass vessel or jar.

Iodoform gauze may be thus prepared:

Salt solution soapsuds	. . .	11 5
Iodoform powder	. . .	10 5
Sterilized gauze	. . .	3 yards.

Mix thoroughly. Rub the solution well into the meshes and when thoroughly impregnated, roll loosely and keep in colored glass jars.

We prepare sterile collodion in this way:

Ether (Squibb's),		
Alcohol (absolute),	. . .	aa 5 viss.

To this add *m* xvi of a solution made by dissolving gr. xv of bichloride of mercury crystals in absolute alcohol 5 xi. Then add of "Anthony's snowy cotton" sufficient to make a syrup.

Sterilizers.—Every surgeon should own some kind of sterilizer, the simplest, best, and cheapest being the Bockmann or Arnold. In one of these the instruments, silk, or silkworm gut, together with towels, aprons, gauze for sponging and dressings, may be sterilized at the patient's home during the hour preceding the operation. On a pinch, gauze or other material to be used as a dressing can be boiled in any vessel or saturated with some antiseptic solution, as carbolic acid 1 to 20 in water, or bichloride 1 to 500. After the soaking the gauze had better be transferred to weaker solutions before being wrung out for use. It is best to keep at hand moist antiseptic gauzes from reliable houses. These gauzes are more convenient, safe, and economical if bought in one-yard packages. The continued reopening of the five-yard packages leads to danger of infection; besides, they are bulky. Very little gauze or cotton is needed in any freshly made wounds unless oozing is anticipated or drainage provided for. A light gauze or cotton collodion dressing is preferable.

Instruments can be sterilized by boiling in any kind of a receptacle; those made especially for the purpose are most convenient. To prevent rusting and to raise the boiling point of the water, add carbonate of soda in the proportion of one tablespoonful to the

quart. If instruments are carefully scrubbed with green soap, turpentine, and warm water, washed off with ordinary clean water and placed into a 1 to 20 solution of carbolic acid in water for half an hour, and then transferred to a weaker solution just before the operation is to begin, they can be relied upon *not* to infect a wound.

Sponges.—Sterilized gauze cut into suitably sized pieces is now most often used for sponging wounds. Sea sponges, if properly prepared, are safe and better than any other material for sponging. All loose sand should be beaten out of the sponges. After this they are put in water, sharply acidulated with muriatic acid, and allowed to remain twelve hours. This will dissolve out all of the lime salts they contain. The sponges are then washed in clear water and put into a 1-20 solution of carbolic acid in water. In twelve hours they are ready for use.

Operating Outfit.—It is good practice to have one's outfit for a proposed operation sterilized at home before leaving for the place of operation. Instruments are boiled, wiped dry with a sterilized towel, and placed in a sterilized canvas roll; in this roll are put needles, silk, and silkworm gut wrapped in a piece of sterile gauze. The roll is then pinned up in sterilized towels. Drainage tubes (glass and rubber), nail brushes, towels, operating gowns (always three or four for use of assistants), bandages, gauze, and cotton, after sterilization in a Boeckmann sterilizer, are similarly wrapped up. Instrument trays are likewise sterilized and protected. A cheap canvas "telescope" of medium size will hold the necessities for any surgical operation. Everything can be carried in one of them, except anesthetizing outfit, jar of iodoform gauze, sterile collodion, iodoform, and boric acid in dusting bottles, turpentine and alcohol, bichloride tablets, soap mixture, antiseptic silk, and catgut. These are put in the surgeon's bag.

Operations in Private Dwellings.—When an operation is to be done in a private dwelling, the best lighted room is selected in which to operate, draperies

are removed as well as all light furniture; the wood-work around the windows and doors is gone over with damp towels. If there is no carpet on the floor, this should be mopped. Although it is preferable to take up a carpet from the floor of a room to be used as an operating room, it is not essential, as the carpet may be sprinkled with water, and that part under and around the operating table protected with sheets. There should be no dusting or sweeping. A visit to the kitchen and other rooms will result in the finding of an operating table, either long enough for the case in hand, or it may be made so by placing a small table at either end to support the head or feet; in lieu of the small table, a box rested upon a chair does very well. In most cases a table sufficiently long to support the head, trunk, and lower extremities as far as the flexure of the knees will do. A short kitchen table can usually be lengthened as described so as to answer the purposes of an operating table better than can the usual extension dining-room table, which is too wide for efficient aid from an assistant when, perhaps, it may be most needed. When the Trendelenburg posture is required and the surgeon has not at hand a Krug frame, or some similar contrivance, the difficulty is easily overcome by tightly pinning a folded sheet or blanket around the four legs of a stiff-backed chair, the sheet or blanket being so fastened that it covers well the bottom of the chair legs. When the chair is placed upon the table in the position of a "bed-rest" it makes a frame upon which, with the legs hanging over the pinned sheet or blanket, a Trendelenburg position of from 40° to 45° is obtained.

One table is selected upon which to place instruments; another for dressing and sponging material. Most any piece of furniture having a flat top will do quite as well as a table for these purposes. Chairs should be placed convenient to both the operator and his assistant, upon which may be placed bowls to contain boiled water or antiseptic solutions in which their hands may be dipped from time to time. The anæsthetizer should receive the consideration of a chair.

In the houses of the very poor, one or two chairs, a box, and even the floor may be made to answer all necessities.

Disinfection of the Skin of the Patient.—When the nature of the case allows two or three days preparatory treatment, the patient should be given some internal medication to stimulate the physiological functions of the skin, and also one or two immersion or sponge baths. During the baths special pains must be taken to thoroughly cleanse the area of a proposed operation wound. Especially ought this to be insisted upon when either the feet, umbilicus, or hairy parts of the body are within the field of a proposed operation.

On the morning of the day of operation, or the evening before, the skin immediately over and for a reasonable distance around the site of the operation must be scrubbed with soap and water, shaved, and then washed with ether or alcohol. It should then be covered with towels or pieces of clean muslin or cheese-cloth which have been saturated in and then partially rinsed out of a solution of bichloride, 1-1,000. It is well to cover this with florist's oiled paper or some other impervious material, as rubber tissue or oiled silk, which has also been washed in a bichloride solution. Over all apply a bandage.

CHAPTER III.

OPERATIVE AND ACCIDENTAL WOUNDS.

Operative and Accidental Wounds.—Wounds may be conveniently classified into those made by the surgeon and those not made by the surgeon. In the first class, when the nature of the wound from its bottom to surface is through non-infected tissue, the reparative process ought to be conducted so as to have union, if desired, by first intention; or, if by granulation, the wound secretion should be free from pus-producing germs. An attempt should be made to bring about the same results in wounds of class 2, whenever they can be brought under treatment sufficiently early. All wounds of class 1 or 2 which are infected primarily or secondarily heal by granulation, with the formation of pus. Most wounds made by the surgeon's knife, when directed through healthy tissue, as for example, for the removal of a lipoma from the thigh, can be managed so as to heal by primary union, or by blood clot. Great care, however, must be taken to place the wound at rest. By rest is meant the removal or prevention of all irritations, chemical or mechanical, which are known to inhibit the healing of wounds. Irrigating fluids, if used at all, must be bland.

Irrigation and Cleansing of Fresh Wounds.—Nothing answers so well as the normal salt solution when the surgeon is reasonably certain that he has been able to safely carry out asepsis. If any doubt exists in his mind as to this most important point, the benefit to be expected from the use of antiseptic irrigating fluids, as carbolic acid 1-40, 1-20, or corrosive sublimate 1-4,000 to 1-500, are immeasurably greater than any bad effect they may have on the reparative process. Carbolic acid, corrosive sublimate, and all other chemicals having the power to kill germs or render them inert also have the property, when applied to fresh, raw surfaces, of causing a more or less profuse exudation of lymph from the blood-vessels

and this unnecessary amount of lymph acts mechanically in preventing accurate approximation of raw surfaces one to another. Besides an amount of lymph in excess of that required for the reparative process is an excellent culture medium for the growth of any germs which may have secured lodgement in the wound and remained unharmed by the chemical in the irrigating fluid. By this it is plain that this trouble can be avoided by careful attention to asepsis.

Control of Hemorrhage, and Suturing Wounds.—When practicable, all bleeding should be controlled by forceps pressure, ligation with catgut, torsion, or hot water, and the wound sponged dry before attempting to approximate its surfaces. The deeper portions of the wound may be approximated by buried, interrupted, or, better still, continuous catgut stitches. The skin surface can be sewed so as to accurately bring the edges together, either by using interrupted stitches or the continuous stitch; sometimes a combination of both. Silkworm gut and silk are preferable for the interrupted stitches, and catgut or fine iron-dyed silk for the continuous line. Whenever fine silk is used as a sewing material, the iron-dyed is the best, as it is more easily seen, and therefore can be more accurately and neatly used than white silk. When there is little tension in the deeper portions of a dry wound the skin may be sutured and the deeper parts sufficiently brought together by the gentle pressure of suitably arranged dressings and bandages. When the deeper parts of a wound cannot be brought together from the bottom up, enough blood may be allowed to escape from the vessels to fill this space, and the skin closed by accurate suture. By proceeding in this way we take advantage of the well known method of repair called "healing by blood clot." In this the clot acts as a mold into which the leucocytes and connective tissue corpuscles and derivatives in the exudate from the wound surface penetrate the clot. As a result of their combined action, connective tissue is developed throughout the clot, which is said to become organized. In this process the clot merely assists the cells, both as a framework and as a food supply.

It is not wise to shut off parts of a deep wound from others by means of buried sutures, when by so doing spaces are left which do not join each other from the lowest to the surface, because, should by chance infection have taken place before the closure of the wound, strong barriers are built against the escape of pent-up poisonous materials, with consequent local, and perhaps constitutional, disturbances. A drain made of sterile gauze or rubber tubing should be placed so as to facilitate the escape of any superabundance of lymph or blood likely to accumulate in pockets. This drain should not be allowed to remain longer than twenty-four, or, at the longest, forty-eight hours.

It is often wise to favor rest by the use of splints, even where no bones or joints are involved. Wounds of the face and neck should be closed with the most painstaking care, using buried catgut stitches for deep wounds, and for the skin the subcuticular stitch of Marcy ("blind stitching" of our grandmothers). Very fine silk, tendon, or catgut introduced with a well-curved needle may be employed for the skin. It is better to dispense with the needle-holder in making this stitch. A cotton or gauze collodion dressing aids in the accuracy of the approximation of the skin edges, and, in special cases, it may be a good plan, in order to secure rest after closure of extensive neck wounds, to steady the head by a plaster bandage passed over copious padding around the neck, head, and shoulders.

In operation wounds in which it is necessary to sacrifice a considerable area of skin, it is often well to dissect up the flaps from the underlying tissue, in order to allow of the easier approximation of the edges. Before sewing the edges together one or several tension sutures should be introduced after the fashion of the quilted suture.

Tension Sutures.—An iodoform gauze pad should be placed on the skin under the loop, and also between the free ends of the suturing material, before making traction and tying. This widens the areas of pressure and prevents the suture from cut-

ting. When it is impossible to draw the edges of a wound together, or when by doing so the nutrition of the flaps may be in part destroyed, it is well to close the gap as much as possible without employing too great tension upon the flaps. After doing this, the raw surface may be covered with skin grafts, either immediately or after the formation of granulation tissue. It is possible, by painstaking asepsis, to bring about repair of these open wounds without the formation of pus.

Dressing of Non-Suppurating Wounds.—Aseptic wounds, from which no leakage is expected, may be sealed with a collodion dressing and further protected by small quantities of dry sterile gauze and cotton, secured by a bandage. Six or eight thicknesses of dry sterile gauze in the form of a pad, somewhat larger than the field of operation, may be put directly over the wound. Absorbent cotton is placed over this and the dressing is fastened by the bandage. The cotton should be liberal in quantity and should cover any bony prominences which may be encircled by the bandage or binder. When drainage has been provided for, the gauze dressings should be heavier and some impermeable material, such as florists' paper, rubber tissue, etc., which has been placed in a 1-20 solution of carbolic acid, or a 1-500 solution of corrosive sublimate is spread out between the gauze and cotton. This prevents infection of the wound, which might result from a putrefaction of the discharge, the germs gaining entrance from without. In that class of aseptic wounds in which it has been impracticable to suture the skin over all of the raw surfaces, the dressing should be the same as just described, with the addition of a second piece of sterilized rubber tissue, slightly larger than the raw surface, which is placed directly upon it. The rubber prevents the gauze from sticking to the wound. Numerous openings are cut in the rubber tissue to allow of the escape of the secretions into the gauze. This same form of dressing is essential if skin grafts have been used.

Behavior of Supposedly Aseptic Wounds.—After the

closure and dressing of the class of wounds under consideration, there may be a complete absence of pain, or only a little smarting complained of, the temperature remaining at normal, or slightly above normal. Should the temperature be 101° Fahr., or higher, and pain in the wound complained of after forty-eight hours, especially if the tongue is coated and the patient is restless, the dressings should be removed and the wound inspected. If there are no signs of inflammation, the condition is probably due to a locking up of the secretions. The dressings are replaced and a brisk cathartic administered. Should the temperature remain elevated after the bowels have moved, the cause is probably some suppuration in the deeper parts of the wound, and an avenue of escape should be made. This is done by removing one or more stitches, preferably at the most dependent part, separating the edges at this place and exploring the deeper parts of the wound with dressing forceps. Pus will commonly be found, and the tract made by the forceps should be widened by separating the blades of the instrument on withdrawing it. A drain should be introduced well towards the source of suppuration. Years ago it was the fashion to squeeze and irrigate such wounds, but experience has taught that they do better if a drain is introduced and a wet antiseptic dressing applied. By following this practice there is less disturbance of the healing process in the uninfected parts of the wound, and the discharge is freely conducted out of the wound and rendered innocuous by mixing with the antiseptic in the moist dressing. This dressing is the same as that for an aseptic wound where oozing is expected, and a single piece of oiled paper or rubber tissue is used and placed between the gauze and cotton, only, in addition, the gauze is soaked in a fairly strong antiseptic solution, as 1-1,000 bichloride, and partly wrung out before being applied against the wound surface. If the inflammation be superficial, whether there be tension or not, enough stitches should be cut to allow of free drainage and the open part of the wound gently sponged with cotton soaked in a 1-20 carbolic acid

solution. Iodoform powder may be dusted onto the wound, but, generally speaking, all powders tend to retard healing by mixing with the secretions and forming crusts under which discharges are retained. The wet bichloride dressing is best in the early stages of these partially suppurating wounds.

If the general condition of the patient is about normal these wounds need not be redressed oftener than every forty-eight hours. When the dressings are changed, the wound should be sponged clean with cotton or gauze, wet in an antiseptic solution (bichloride, 1-1,000) and carefully inspected. If inflammation has not spread to other parts and the wound looks healthy, nothing further is necessary than to reapply the dressings.

Treatment of Infection of Supposedly Aseptic Wounds.
—Should, however, other parts of the wound, either at the edges or stitch-holes, show a further infection, even if only slight, the stitches must be taken out. If pus does not show itself at the stitch-hole openings upon pressure, the lips of the wound should be gently separated and a smaller or greater amount of pus will be found. A deep wound affected superficially in this way, without much swelling, deeply situated pain, or elevation of temperature, should not be further disturbed by opening it up. An attempt may be made to thoroughly destroy all germs present, both on the infected surfaces and in the tissues themselves, by using some strong antiseptic, which also has cauterizing properties. In liquid carbolic acid we have such an antiseptic, and the pain and cauterizing action of the acid can be immediately controlled by applying alcohol directly to the surface upon which the carbolic acid is acting. For open surfaces, the acid and alcohol is applied on cotton held in a dressing forceps. For stitch-holes and small cavities and tracts, the acid and alcohol can be easily made to reach every point if applied upon cotton wrapped around a probe. After such treatment, a moist antiseptic dressing should be used and changed daily. It may be necessary to employ the carbolic acid and alco-

hol a second time. Iodoform gauze may be used with advantage as a material to be gently packed into the wound. The iodoform acts by modifying the action of pus-producing germs, although it does not prevent these germs from multiplying; the gauze acts as a drain. Should the whole, or a greater part, of the wound become infected, it should be opened up from top to bottom and managed as indicated above.

Should there be a tendency to sloughing, with maceration and putrefaction of sloughs, there is no agent which will check this so quickly as formaldehyde (40 per cent. solution). Of this we use for sponging and irrigation, a solution in water, of a strength varying from one dram to one ounce to the quart. If wounds remain aseptic and drainage has not been employed, dressings need not be disturbed for from five to ten days, according to the character and position of the wound.

Stitches and Their Extraction.—Usually stitches have served their purpose at the end of these periods, and should be removed. To remove an interrupted stitch it should be cut close to its entrance into the skin on one side and then, with a forceps, it is extracted by gently drawing the long end toward the side which was cut. By taking out threads in this way there is little danger of separating the lips of the wound, should union be weak. The extraction of interrupted stitches is made easier if the knots are all tied upon one side. This tying is done by drawing one end of the stitch, after tightening the first loop, towards and across the wound, thus bringing the knot almost directly over the point of entrance of the other end of the stitch into the skin. In wounds of the scalp, and often in other localities, it is especially desirable that tension upon the stitches should never be allowed, that is, post-operative tension due to inflammation or the accumulation of fluids under the flaps. To prevent this, and still at the same time give accurate and sufficient support for normal conditions, interrupted stitches of well-softened silkworm gut should be used. One end of the

stitch is carried twice around the other and tightened directly across the lips of the wound. This is the "surgeon's knot," without the final or fastening loop. These stitches give sufficient support for normal repair, but will give away under abnormal tension. In removing a continuous stitch it should be cut along one side close to every skin puncture, and the separated parts removed as are interrupted stitches. The subcuticular continuous stitch, used for approximation of skin edges, is removed by making traction upon one end. Stitches of absorbable material should not be interfered with, unless they produce irritation, when no time should be lost in taking out every particle, for they serve too well as culture media for germ growth. After the removal of stitches it is often well to give support to the newly repaired wound by using collodion, or where a strain may be expected, adhesive plaster is useful. Especially made binders are almost essential for the support of long wounds through the abdominal walls. Many surgeons insist upon their patients wearing these supporters in order to prevent the formation of hernia, which is apt to occur in a small percentage of cases after abdominal section. In fat subjects and those having much lifting to do, the support should be worn six months, or even longer.

CHAPTER IV.

OPERATIONS ON INFECTED TISSUES.

Wounds Made into Infected Tissues.—When it is necessary to make incisions through apparently healthy tissues in order to reach infected areas, it is usually best to treat the resulting wound as one which must repair, in part at least, by granulation with the formation of pus. Should the operator feel sure that all foci of suppuration have been removed, even if the wound has been more or less soiled by pus during the excision, after thorough disinfection it may follow that by accurate suture complete repair will take place, union being by first intention. However, such a result is rather exceptional. Usually there will be a greater or less failure of the primary reparative process, and some suppuration follow. Therefore it is wiser to close such wounds in part only, leaving at the most dependent place an opening extending from the bottom to the surface. A drain, either of rubber tubing or iodoform gauze, should be inserted, and if after forty-eight hours there is complete evidence of the absence of inflammation in the wound, the drain ought to be removed. This drain acts as a safety valve, should the effort to obtain primary repair prove futile. In either case, the dressings and treatment should be as indicated for non-infected wounds, or those made by the surgeon in which a faulty technique was rewarded by more or less infection.

If an incision is carried directly through inflamed tissues, although there is an absence of surface suppuration, the prime object of the use of the knife would be lost unless the wound were kept open. These incisions, whether single or multiple, long or short, are made for the purpose of relieving tension, and for the evacuation of fluids whose retention may, in a circumscribed or spreading fashion, tend to cause pain, prolong illness, or even threaten limb or life. Therefore, free drainage must always be employed and

the greatest care is essential, that while a reparative process is supplanting the inflammatory one in the infected tissues, no hindrance should be allowed to the free escape of all secretions from the deepest recesses to the skin edge.

In acute circumscribed inflammations, with the more or less complete breaking down of all of the tissues involved, it is usually sufficient, after an incision, to gently irrigate the wound cavity with an antiseptic solution of medium strength (bichloride, 1-2,000) and drain by using a light iodoform gauze packing, the discharges being received into a moist antiseptic dressing protected by some impervious covering. The dressing should be changed daily until all signs of inflammation have disappeared; usually in from two to five days. Then it is better to use as a drainage material a strip of iodoform gauze soaked in castor oil, or in castor oil and balsam Peru, 5 to 6 per cent. of the latter. Sterile gauze is usually quite as efficient as the iodoform gauze, and much cheaper, but generally it may be stated that until granulations begin to form for repair, iodoform gauze is better. A good sized piece of sterile gauze soaked in the oil dressing is placed over the end of the gauze drain, and over this is arranged some oiled paper or rubber tissue, and over all, cotton and a bandage. This dressing need not be changed oftener than every second or third day. Irrigation is unnecessary, as there is nothing to wash away. All of the discharge finds its escape along the drain into the medicated dressing under the impervious protective. There is no drying out and sticking of the dressings so that discharges are pent up and decomposed in the wound. Gradually, as the wound fills from the bottom, the dressing should become smaller in bulk, and as the granulations reach the surface of the incision, it should be allowed to close. This may be aided often by drawing the edges towards one another, using adhesive plaster. Before applying the plaster the wound must be protected with some light non-irritating antiseptic dressing. Boracic acid ointment of about one-fourth strength spread on lint or

sterile gauze is an excellent dressing at this stage of the wound repair.

In infectious inflammations involving considerable areas, as, for instance, in more or less diffuse cellulitis of the extremities, or of the parts involved in extravasation of urine, the only hope of limiting the spread of the inflammatory process is to establish free drainage by suitable incisions. Such wounds have to be kept open, using large fenestrated rubber drainage tubes or gauze. The rubber tubing is preferable, and often it is good practice to connect well placed openings by the same piece of tubing. Gentle pressure and irrigation with some antiseptic solution is useful to remove pus and debris. Little good is to be expected from the irrigating fluid except its mechanical action. So, usually, it is best to limit this interference with repair to the purposes mentioned. Copious moist antiseptic dressings are essential and these must be removed every twelve to twenty-four hours until it is evident that inflammation has ceased to spread and that repair is well established. In addition to the tubing, gauze may also be employed to aid in keeping the incisions from closing too soon. When, as a result of the incisions, dressings, etc., the inflammation has become a local one, the conduct of the after treatment should be along the same lines as advised in acute circumscribed inflammations. It may be evident, from the virulence of the inflammation, that more severe measures of treatment are necessary, either after the line of practice for the management of suppurative cellular inflammation has failed to stay its spread, or where from the first simple incisions for the purpose of drainage were recognizedly insufficient.

Open Drainage for Disinfection.—Under such circumstances, it is often the best practice to lay the parts wide open by free incisions, not only with the purpose of gaining absolutely open drainage, but also an opportunity to mop the infected tissues with liquid carbolic acid or tincture of iodine (possibly somewhat diluted with alcohol). These strong antiseptic agents will usually penetrate so as to destroy the infecting

element and as a result establish a reparative in the place of an infective process.

Dressing After Disinfection.—Iodoform gauze is the best material to lightly pack into these wounds, and the packing and antiseptic dressings should be changed once or twice every twenty-four hours until the discharge becomes moderate in amount and healthy in character. Campho-phenique gauze is a valuable drainage material. It is antiseptic, anesthetic, and drains a little better than iodoform gauze. Occasionally incisions for the relief of the tension and spread of cellular inflammation are made so late that intermuscular planes have become invaded and pus has found its way towards parts at some distance from the surface. Such circumstances will be discovered by the exploring finger, always introduced into the incisions for the purpose of ascertaining whether or not this condition is present. When so, the drains must be placed so as to reach the bottom of the infection, and perhaps, in order to do this and perfect the drainage, it may become necessary to make dependent openings through healthy tissues. This is most commonly necessary in the extremities when so-called "through and through drainage" is established. In freely opened septic wounds, irrigation at each dressing is required to loosen and help wash away sloughs formed as a result of the inflammation and powerful antiseptics employed.

As the repair progresses, drainage tubes should be shortened. Often tubes of small caliber can be substituted for the larger ones. These extensive suppurating processes are very depressing and the system should be supported by alcohol, strychnine, and forced feeding. Opium should be given to control pain, and in the later periods of the infection to check diarrhea.

CHAPTER V.

ACCIDENTAL WOUNDS.

Wounds Not Inflicted by the Surgeon.—When accidental wounds are of the nature of incised wounds they are treated much the same as are wounds made by the surgeon through non-infected tissues. The surface about the wound is prepared by the method given for an antiseptic operation. In addition, the lips of the wound should be separated and the raw surface disinfected. Great care must be taken to remove any foreign material, and especially should this be insisted upon if the circumstances of the injury point towards the possibility of street or stable dirt having gained entrance into the wound, because of the danger of the presence of the tetanus bacillus in such dirt. Under these conditions, the disinfection should be most thorough. Alcohol, liquid carbolic acid, and tincture of iodine are among the most useful agents for this disinfection. If the surgeon is reasonably certain that he has a clean wound to deal with, it ought to be sutured and some suitable antiseptic dressing applied. Under all other circumstances it is wiser to leave the wound, in part at least, unsutured. An antiseptic dressing must be used. If after a few days there is complete absence of inflammation, the wound may be closed by suture or the edges approximated with adhesive plaster drawn over antiseptic gauze applied next to the wound. If infection has taken place, the treatment should be as already described for similar conditions.

The nature of an accidental (possibly homicidal or suicidal) incised wound may, from its anatomical location, prevent any primary attempt at cleanliness, because of threatened danger to life from hemorrhage, but after this has been overcome, thorough antiseptic details should be followed. If nerve trunks or muscles have been divided the ends should be carefully sewed to their proper fellows before closing the wound. These kinds of complicated incised wounds

are most often seen near joints where muscles, tendons, and nerves are situated in shallow spaces between the skin and the bones. Incised wounds of special parts of the body must be dealt with according to the recognized surgery of the particular structures or organs involved. Categorically speaking, it may be stated that the control of hemorrhage should be the first object. The second should be the removal of all foreign substances, as dirt from without, or, in case of a wound of the intestine, soiling from within. Third, after thorough cleansing, all damage should be most painstakingly repaired. These must be dealt with before any attempt at closure of the outside wound is undertaken.

Simple contusions, or bruises, are best treated by hot water, used by immersion if the injury is of an extremity. When the head or trunk is the locality injured, cloths wrung out of hot water and frequently changed are very effective. This treatment lessens swelling, checks extravasation of blood, and relieves pain. After the first twenty-four hours, gentle massage may be begun and continued daily. A flannel bandage applied directly to the skin, or over cotton or lamb's wool, is effective in giving support and in aiding absorption of extravasated blood and irritation exudate.

Lacerated wounds, which may be more or less contused or crushed, are of the most serious class of injuries the surgeon is called upon to treat. The extent of destruction of both soft parts and bones is not uncommonly so great that the shock to the nervous system is overwhelming and causes death either immediately or within a few hours. Fortunately mild tearing and bruising of the tissues is the rule; the more serious injuries result from entanglement in heavy machinery, or the mutilation of limbs by car wheels.

Shock.—Lacerated wounds, whatever their kind, require an especial examination. Before, however, expending any time further than to perhaps remove the clothing so as to gather a respectable idea of the

character of the injury, the general condition of the patient should be investigated. If there is marked derangement of the nervous system, evidenced by a small, unnaturally rapid pulse, partial unconsciousness, or an exhilarated state of, "I'm all right," clammy skin and pale or ashen face, restorative measures are necessary before any attention to the injury itself is undertaken, unless hemorrhage is going on. When there is any hemorrhage, even though moderate in amount it should be checked, catching the bleeding vessel or vessels with artery clamps will suffice for moderate superficial bleeding, but when the blood comes from several vessels of large size and many small vessels, as may be the case in some injuries of the extremities, the best practice is to apply an elastic tourniquet so as to control the bleeding. If the patient's general condition is so bad that a further examination might add to the shock, it is wrong to interfere. The shorter the distance a patient suffering with severe shock is moved from the place of accident to where he may receive first aid, the better. The essential restoratives are,—after checking bleeding and applying some protective antiseptic dressing,—absolute quiet, artificial heat, the administration of drugs. Desperate cases require nice judgment, and in the administration of drugs to combat shock, the desire to do something often warps one's judgment.

For many years alcohol and opium were the sheet anchors in the treatment of shock, but of late alcohol is being discredited and not much is heard of opium. The hypodermic administration of strychnia is the remedy most relied upon, and in case of much loss of blood, its volume is replaced, in part at least, by the intravenous injection of hot normal salt solution. The strychnia is given in doses of 1-30 gr. to 1-10 gr., repeated every one to four hours, *Tr. digitalis*, 10 m., 30 m. may be given hypodermically. Nitroglycerine, 1-100 gr., and atropia, 1-100 gr. are often used. It is the opinion of the writer that opium in the form of morphine is useful, in fact, a *sine qua non* in bringing about an equilibrium in the nervous system, it is also

PLATE I.



A crushing wound (railroad) of both legs. Elastic tourniquets applied to control hemorrhage. (From a patient in the Clarkson Hospital.)

a powerful stimulant. Lives are occasionally sacrificed by the administration of too many and too powerful "heart stimulants." Absolute quiet brought about by favorable surroundings and the use of just enough morphine to soothe the disordered nervous system are of more value than all of the so-called heart stimulants. Strychnia acts as a stimulant to the respiratory and circulatory centers; it also has a direct stimulating effect upon the heart muscle, but strychnine acts upon the vasomotor nerves and contracts the arteries. It is often observed that the pulse of shock indicates the presence of an abnormally small amount of blood in the arteries; the superficial veins indicate the presence of a full quantity of blood in these veins, and it is reasonably sure that the abdominal veins are pretty full. Although strychnia does stimulate the heart, unless given in a well guarded manner, it may so contract the arteries as to increase the accumulation of blood in the veins and overwhelm the right heart. Therefore, when strychnia is given in large doses it should be administered in conjunction with nitroglycerine or belladonna, preferably the latter if the skin is cool and clammy. Digitalis possesses, in a measure, the properties of strychnia; its action upon the blood vessels is less marked, however, and may often, with advantage, be substituted for it. Digitalis helps to unload excrementitious materials by its action upon the kidneys and thus adds to its usefulness.

Contused and lacerated wounds, whatever their degree, require careful antiseptic digital examination to determine the extent of injury to the soft parts, and often, also, to the bones. Most any kind of grease, dirt or foreign substance, may have been forced into the deeper recesses of the wound, so the future behavior of the wound will depend upon our ability to remove all such material and thoroughly disinfect. In such wounds, except those of a trivial kind, drainage must be established. Whenever there is extensive laceration and disturbance of the soft parts, especially if bones are broken, several openings ought to be arranged and rubber tubing placed to provide

for a free escape of hemorrhagic and exudative fluids. If the surgeon's efforts to remove all infection producing substances have been unsuccessful, the drainage tubes afford an escape of inflammatory products and the danger of constitutional poisoning and local inflammatory destruction are reduced. Copious irrigations with some strong antiseptic fluid, as bichloride 1-500, 1-1000, or carbolic acid, 1-20, is demanded in the first preparation of the wound. Later, milder irrigating solutions can be used. Antiseptic dressings should envelope these wounds, and even when bones are uninjured, it is often wise to employ splints when the wounds are of the extremities, especially if in close proximity to joints. The quieter the parts are kept the quicker the repair and more circumscribed any inflammatory condition that may arise.

Indications for Amputation.—Sometimes it is good practice to cut away certain soft parts, whose vitality is destroyed; but unless this tissue is merely hanging by shreds, it is wisdom to wait until nature has demonstrated positively the death of tissue. When, from the nature of the crushing force, combined with a careful examination of a resulting wounding of an extremity, it is positively certain that the blood supply is totally destroyed, amputation is demanded, and this operation ought to be done as soon as reaction from shock is established. This refers to profound shock, which nearly always exists when more than one extremity is crushed or the injury is near the trunk, especially of the lower extremity. When shock is not very marked and an extremity, or extremities, hopelessly devitalized, the sooner amputation is done the better, as the removal of such parts lessens nerve irritation. Moreover, the danger of septic infection is reduced. If the blood supply left after one of these injuries is sufficient to keep up the vitality of an extremity, it should never be amputated as a primary procedure. With our improved modern antiseptic surgery, the possibilities of repair are almost unlimited. In case of failure to preserve a useful limb, this may be removed as an operation of election.

Fourth of July Accidents.—There is a form of lacerated wound sometimes appearing of little consequence, but often followed by tetanus. It is generally a Fourth of July accident and follows the entrance of small pieces of the cap used on "toy" pistols, parts of fire crackers, etc. Wounds caused in this way should be freely incised so as to get at the deepest recesses and remove every particle of foreign substance discoverable. They should then be disinfected with pure carbolic acid and alcohol and kept open with iodoform gauze packing. The only safe way to treat these wounds is upon the open method, repair being by granulation. It ought to be borne in mind that any injury which leaves a foreign body other than a bullet in the tissues is liable to be followed by tetanus.

Punctured wounds, whether from their anatomical location, they involve joints, organs of the chest and abdomen, the brain, or merely soft parts, are serious injuries. When the inflicting instrument happens to be a clean one the wound is less likely to be dangerous than any other kind of wound, provided no vital organ is injured. Sometimes these wounds cause concealed injury, such as opening into an intestine, or bladder, and the secondary inflammation may be fatal. The chief danger of punctured wounds lies in the fact that infective germs are introduced with the entering instrument, and the nature of the wound tends to retain these germs, so that they can gain a firm foothold. Wounds which bleed freely and allow of an open escape of blood are not usually infected at the time of their causation. Flowing blood does not favor germ implantation and growth. Punctured wounds, unless a large vessel is injured in the direct course of the puncturing instrument, seldom bleed much. What bleeding does take place usually extravasates around the track of the wound; therefore any germs which enter at the time of injury are securely placed for growth.

Punctured Wounds of Hands and Feet.—Punctured wounds are met with most commonly in the feet and hands and are often followed by serious consequences. A deep-seated suppuration may be set

up, commencing in the aponeuroses, deeper connective tissue or tendon sheaths, and because of the resisting structure of the anatomical arrangement, suppuration cannot approach the surface until extensive involvement, even destruction, of not only the soft parts, but also the bones has taken place. There is invariably great pain, greater or less swelling with dusky redness. The fingers or toes soon lose their motility, likewise the wrist, or even the ankle. If active surgical interference is not instituted early, contraction of the tendons and palmar or plantar aponeurosis follows with permanent disability. In neglected cases, suppuration may extend upward considerable distances. High fever is the rule, and even such a grade of general infection may occur as to cause death.

The proper treatment of this form of inflammation is by early, free incision; the knife must be carried to the bottom of the infection and gauze or tubular drainage instituted. Sometimes several incisions are necessary. In using the knife, care should be taken not to divide tendons or the arterial arches. These latter, however, are of minor importance. After dividing the more superficial parts, the finger, or some blunt instrument, may be used to reach and open up the deeper parts. Incisions should be directed in the long axes of the tendons, never at an angle.

These inflammations not infrequently result from slight superficial abrasions sufficient to allow of the entrance of germs. Again, they may follow bruises without visible breaking of the skin. This is explained by the fact that the bruise results in a circumscribed lowering of the vitality of the tissues, and any germs capable of exciting inflammation which may be present in the circulatory or lymphatic channels in this locality, have an easy prey, the normal resistance to germ action being overcome by the lessened vitality caused by the bruise.

The treatment of all contused, lacerated, and punctured wounds belongs strictly to antiseptic and not aseptic, surgery.

CHAPTER VI.

PUNCTURED WOUNDS OF THE BRAIN.

Clinically, these injuries seldom occur except through the orbital plate of the frontal bone. A very few rare cases have been reported of the puncturing instrument entering through the nostrils. An instrument may be driven through the skull at any part and wound the brain. A considerable variety of instruments have been known to penetrate the brain by way of the thin orbital plate of the frontal bone, the most common having been umbrella sticks, canes, pieces of wood, narrow-bladed instruments of warfare, etc. The eye not uncommonly escapes injury when the entering instrument fractures the orbital plate near the superior orbital fissure. In such cases, the wound first passes through the upper eyelid. A part of the puncturing instrument may remain in the brain. The injury to the brain is usually confined to the frontal lobes, but may involve other parts. If the brain is punctured through the optic foramen, the eye is almost certainly injured, and the optic nerve is necessarily crushed or divided, unless, perchance, the puncturing instrument is of very small diameter, like a hatpin. Besides any injury to the eye which may complicate these accidents, the main danger lies in the brain lesion. Not so much, usually, the immediate results from destruction of brain tissue, as the secondary inflammatory processes likely to arise as the effect of the injury. Hemorrhage may be sufficient to produce dangerous pressure symptoms, but this will hardly occur unless the injury is through the floor of the orbit towards the vessels at the base of the brain.

The treatment of these injuries should be directed towards an exposure of the injured parts sufficiently extensive to enable the surgeon to examine carefully for the presence of a foreign body when from the his-

tory of the case such a body may have remained in the wound. The surgeon should not limit his interference until he has cleared a passage for careful irrigation and drainage of the injured brain. Although it may be necessary to boldly open up the skull in front of and above the track of the wound, usually it will suffice if, after shaving the eyebrow and using the usual antiseptic precautions, the orbital plate of the frontal bone is exposed by making a free curved incision along the upper edge of the orbit down to the bone, separating the loose, cellular tissue, and depressing the globe with a small flat retractor. By this means sufficient space will be secured for the exposure of the wound. With small chisels the opening through the bone is enlarged sufficiently to explore the wound and provide for drainage. The accompanying photograph was taken from a child that had fallen upon a rusty, dirty buttonhook with which it had been playing. The hook end of the instrument had passed through the upper lid, the orbital plate of the frontal bone, and into the brain. The hook had in some manner rotated so that it was necessary to remove considerable bone before it was extracted. The writer followed the practice just recommended and recovery was entirely satisfactory. Should the brain be punctured through the optic foramen, the eyeball must be removed to admit of proper exploration and drainage. In such a case, even if the globe of the eye is not injured, the optic nerve probably is, and in any case it is better to sacrifice the eye than to invite secondary inflammatory conditions in the orbit, and maybe in the brain. A good general rule would be that in all cases, the bottom of the wound should be explored and drained by the most direct route, preserving the integrity of an uninjured eyeball when possible. If the eyeball is wounded and probably infected it should be removed. The inflammatory swelling of the loose connective tissues of the orbit is a source of great danger. The swelling interferes with drainage, and inflammation may pass from infected orbital tissues along the track

PLATE II.



Punctured wound of the brain through the orbital plate of the frontal bone. (From a patient in the Clarkson Hospital.)

of the wound to the brain. When practicable, the counsel and assistance of an expert oculist should always be sought in the treatment of these complicated injuries.

In those rare wounds of the brain through the nostrils the base of the brain should be freely exposed by making an opening through the frontal bone. Most painstaking antisepsis must be employed so as to limit probable infection derived from the nasal cavity.

CHAPTER VII.

PENETRATING WOUNDS OF THE CHEST.

Even in civil practice a large percentage of wounds of the chest are caused by bullets, yet not a few are made by sharp-pointed instruments of various kinds. The general principles involved in the diagnosis and treatment are essentially the same. We can best classify puncturing wounds of the chest into those which pass through the chest wall into the pleural cavity, and those which, after penetrating the costal pleura, wound the lung, pericardium, heart, or large vessels. The first variety is not usually immediately serious, but may become so; the dangers are hemorrhage from the wounding of an intercostal vessel or a secondary septic empyema. Rare cases have been recorded of hernia of the lung. When the wound is low down, the diaphragm may be divided and omentum or intestine pass upwards through the wound in the diaphragm.

Wounds of the lung are very dangerous when the inflicting instrument, if a bullet, is a large one and passes into or through the lung near its base. The same rule applies to wounds from knives and other sharp-pointed instruments. Small wounds into or through the thin edge of the lung are not very dangerous.

Wounds of the heart are usually immediately fatal. Wounds of the pericardium, although exceedingly serious, are recoverable. Penetrating wounds of the mediastinum which are not immediately fatal from hemorrhage will become most serious should infection occur.

The diagnosis of penetrating wounds of the chest depends mostly upon a good knowledge of physical diagnosis and the meaning of the symptoms of shock and hemorrhage. If after antiseptic precautions a sterile probe enters the pleura, the wound is a pene-

trating one. If the inflicting instrument is small, and the wound of entrance over and its supposed direction towards the thin portions of the lung and away from the heart and chest center, the presumption is that comparatively little danger is to be anticipated, especially if all symptoms of hemorrhage are absent.

Symptoms of Hemorrhage.—The raising of bloody sputa proves pretty well that the lung is injured. The more or less rapid accumulation of fluid in the pleural cavity indicated by the physical signs of hydrothorax or hydropneumothorax, accompanied by the usual general symptoms of internal hemorrhage, proves that blood is accumulating in the pleural cavity. If the force, size, and direction of the bullet or cutting tool indicate a lung injury, especially if some blood, even a little, is coughed up, the source of hemorrhage into the pleura is probably from a wound in the lung. The pneumothorax may come from inspired air or from air being sucked into the chest through the wound in the chest. Hemorrhage from the wound, if bright red and spurting or active, comes from an intercostal or internal mammary artery; if dark and flowing in character, it is probably from the lung. Emphysema, when present, usually comes from air which has been inspired. The air may have come from without into the wound. The greater the shock the more serious the injury, especially if the temperature is subnormal.

In a recent case of the writer's where there were two wounds made by a large bullet, the wounds of entrance and exit being five inches apart, he was able to demonstrate that the lung was not injured. This proves that in rare instances it is possible for a wound of this character to exist without perforation or even grazing of the lung.

Wounds of Pericardium and Heart.—The differential diagnosis between wounds of the pericardium and wounds of the heart may be insurmountable. In both there is apt to be sharp pain, more intense if the heart is injured. Dyspnea is more marked if the heart is injured and the physical signs of the presence of fluid

in the pericardium are present almost immediately and increase rapidly.

In pericardial wounds the cardiac syncope is not so great, because there is less rapid accumulation of blood in the sac. A wound of the heart may of itself cause death almost immediately or in a short while, but when death is delayed a few hours it is usually due in great part to overdistention of the pericardium with blood. Death may result from secondary inflammation. In wounds of the pericardium death is due to the same causes.

The treatment of penetrating wounds of the chest involving the chest wall and lung is usually best limited to the internal administration of opium and the local application of a primary antiseptic dressing. If the chest wall is at all lacerated, hemorrhage should be controlled, all loose fragments of ribs and any foreign body discoverable removed, and drainage provided. If a ball has passed through the chest and lodged under the skin, it can be removed, but it is folly to probe or explore with the finger in order to discover a bullet in the lung. There is great danger of setting up hemorrhage or inflammation. Secondary operations within the pleural cavity, or even the lung, are safer than too active interference in primarily dangerous injuries. Unless dyspnea points towards impending death from the loss of blood and its accumulation in the pleural cavity, surgical interference is not indicated. Absolute rest should be enjoined, ice applied to the chest, and opium and ergot given internally. If the source of the hemorrhage is thought to be an intercostal artery or the internal mammary artery (we can tell something about this from the relation of the wound to the ribs and its position in the chest), it should be exposed and tied.

Aspiration or incision for the evacuation of blood from the pleural cavity may be practiced if suffocation threatens death, but in these cases death may follow from a continuance of the bleeding. Under such conditions there may remain nothing to promise hope other than a bold resection of a sufficient number

of ribs to allow of the packing into the pleura and against the lung of a sufficient quantity of sterile gauze to control the hemorrhage.

Pneumothorax and empyema resulting from infected blood accumulations are treated upon general principles, viz., the former may be aspirated, the latter can only be treated successfully by incision and drainage.

A wound of the heart had better be left to nature. She sometimes brings about recovery. These wounds have been dealt with successfully. The pericardium is exposed by either an osteoplastic resection of the ribs or a permanent resection. The pericardium is then incised and the wound in the heart repaired by suture. Drainage must be provided for accumulations within the pericardium. If a case of wound of the heart or pericardium, or both perhaps, threaten death from blood pressure within the pericardium, the sac ought to be aspirated, or even drained.

Hernia of the Lung.—A hernia of the lung following a wound of the chest should be reduced and the wound closed by suture and supported by suitable dressings. Should the diaphragm be wounded, a complication of a penetrating wound of the chest and a protrusion of omentum or bowel into the chest follow, the condition might be recognized by physical signs, and the symptoms of obstruction of the bowels. A free opening into the chest should be made in a suspected case of this kind, and if a hernia is discovered it should be reduced and the wound in the diaphragm sewed up.

Penetrating wounds of the mediastinum require the most painstaking antiseptic treatment.

CHAPTER VIII.

TREATMENT OF INCISED AND PUNCTURED WOUNDS
OF THE ABDOMEN.

The general principles of surgery involved in the treatment of penetrating gunshot wounds of the abdomen apply equally to lacerated, incised, and punctured wounds of the abdomen, produced by blunt or irregularly shaped bodies and by those of broad or narrow keen-edged instruments.

All non-penetrating wounds of the abdominal wall should be treated upon the same principles as wounds of the same kind in other parts of the body—particular attention being paid to accurate approximation of the separate muscles and fasciæ by buried sutures. When doubt exists in the mind of the surgeon as to whether or no the peritoneum has been opened, digital and instrumental exploration—with, if necessary, careful enlargement of the wound—will usually decide this point; or, being still unsettled, the abdomen may be opened in the median line and the peritoneal area of the abdominal wall beneath the wound examined by sight and touch.

If inspection or the examinations just indicated demonstrates that the peritoneum has been opened, the line of treatment to be followed is clear and positive. Those in which there may be greater or less protrusion of omentum and intestines, one or both, should be carefully washed with warm sterilized water, any bleeding mesenteric vessels tied, and the wounds stitched. Then the protruding parts should be carefully washed again and returned into the cavity and the abdominal walls sutured. This treatment is absolutely necessary to save life, and may be done by any physician. In all cases, whenever it is uncertain what the extent of the injury may be, whether or no any viscus is wounded, the abdomen should be opened, usually in the median line, and a careful search made for

injuries, and, if found, they should be repaired by the simplest and most rapid methods consistent with accuracy. It is oftentimes impossible to tell if a viscus has been wounded, no matter what the shape of the offending instruments or the locality of the wound where it was forced through the abdominal walls. There may be little or no shock or symptoms of hemorrhage, and yet extensive trauma exist. The many differentiating signs between involvement and non-involvement of the various abdominal viscera after penetrating wounds of the abdomen are valuable, but all are unreliable and not absolutely to be depended upon, and there are no means, short of abdominal section, by which this can be positively determined. Stab wounds are more likely to be followed by hemorrhage than bullet wounds; yet the instrument does not so often injure the bowels, especially if they are comparatively empty. The swift-moving bullet enters the intestine whether distended or empty; the cutting, slowly moving instruments may simply push them aside. The use of hydrogen gas, as recommended by Senn, is perhaps the most trustworthy method of determining whether or no the stomach or intestine has been wounded, and also of determining whether or no all of the openings possibly made into the viscera have been sutured. The employment of hydrogen gas in these cases is more scientific than practical, and when shock predominates its use is contraindicated as consuming too much time.

*Prognosis.**—The most recent statistics of the results of operations for stab wounds of the abdomen (Gaston's tables) contain twenty-eight cases in which abdominal section was done, with sixteen recoveries; of this number, nineteen had wounds involving one or more of the viscera and of these ten recovered and nine died. If it is known that a cutting instrument has entered the abdomen, the wounding of the viscera is to be assumed, yet "penetrating wounds of the abdomen

*The writer recently operated upon a young man for a stab wound of the abdomen, who recovered in spite of the fact that leakage had occurred from two wounds of the transverse colon. The operation was done within two hours after the injury, hence the recovery.

without serious visceral injuries and without the presence of a septic foreign body in the abdominal cavity are frequently followed by recovery without resort to intra-abdominal treatment." In fact, in about 10 per cent. of all penetrating wounds of the abdomen the viscera escape injury. This well-known truth that very many persons whose abdomens have been punctured by jagged, blunt, or sharp-pointed instruments have gotten well without surgical interference brings us to what may be considered the most important part of this subject, and that is: When it is uncertain what the extent of the injury may be, whether or no any viscus is wounded, we should reserve explorative measures for the determination and the repair of such injuries to the hands of a trained modern surgeon of experience in the practical workings of aseptic surgery. The services of such a man can always be had nowadays, or, circumstances possibly preventing, a young man who has been taught practically how to do intestinal surgery upon the human cadaver and living animals, and has acted as assistant in hospitals or private practice to men who do clean work in the strictest sense, should be called. The management of these grave cases should not be trusted to any others. It is rather amusing to read from time to time about abdominal surgery upon the battlefield. Of course, these effusions come from men who never saw a battle, except in prose, verse, or upon canvas. As the perfection of modern war implements has not yet done away with the saber and bayonet, it is to be expected that incised and punctured wounds of the abdomen will be inflicted in future wars, and perhaps some of them come into our hands for treatment. For this reason the writer ventures to call attention to the opinions of his preceptor, one of our leading authorities in such matters Dr. Wm H. Forwood, United States Army Professor of Surgery in the Army Medical School. The opinions of the doctor refer more especially to gunshot wounds, but apply to the class under consideration just as well. He says in substance:

"Laparotomy for gunshot wounds of the abdominal viscera, unlike many other operations in military surgery, will always be greatly restricted in its application and usefulness by the very exacting conditions necessary to success. Wounds of the viscera do not admit of delay. There is no way to prevent sepsis, as in external wounds. The time that may elapse before an operation must be done is limited to from three to five hours, after which the chances of success diminish very rapidly.

"The operation must be done at the hospital, in a warm, quiet room, protected from wind and dust, with good lights, competent assistants, plenty of time, and the advantage of the strictest antiseptic precautions. Very exceptional qualifications are demanded of the surgeon. None but those having skill and special training in this line and who have had considerable experience at least on the cadaver and on living animals should dare undertake it. The mortality from laparotomy for gunshot and stab wounds of the intestines done by inexperienced operators will be much greater than that under the expectant plan of treatment. Except in siege operations, the hospitals will very rarely be established in time to offer the benefit of this operation to those wounded in the early part of an engagement. Very few of the severely wounded will be able to reach the hospital under ordinary circumstances within five hours after the receipt of their injuries. Men with penetrating wounds of the abdomen suffer from shock and hemorrhage, and often have to remain for a time on the field, and they usually have to be carried long distances on litters. Such cases are brought to the hospital in the evening, or during the night, when the difficulty of operation is increased by want of proper light, or more frequently not until the following day, when it is too late. An operator with requisite skill and experience will rarely be available, and when there are many wounded, the services of two or three of the best surgeons for an hour or two of precious time can seldom be given to the doubtful benefit of one among

a number of men urgently needing assistance. Battles result in defeat as well as in victory on one side or the other, and among the wounded prisoners the benefit of laparotomy will hardly be realized, although some antemortem abdominal sections may be made by well-meaning surgeons with more zeal than discretion. On the whole, the outlook for future operative interference in cases of penetrating wounds of the viscera on the battlefield is not very promising. But still there will be exceptional cases and especially favorable circumstances where this procedure may become practicable."

Technique.—Fine iron-dyed silk and ordinary round sewing needles are the best material for closing wounds of the intestines, and if the wound is over one centimeter in length we can use the continuous Lembert sutures, otherwise the interrupted. If there is no hurry, it is best to use a double row of sutures. If the trauma demands excision of any part of the gut, and if there is no great urgency, end to end anastomosis by suture is a good method,—if the case is urgent a Murphy button may be employed. Blood-vessels may be tied with silk or catgut. Wounds of the liver should be sutured, or the wound of entrance may be tamponed, or if a through and through wound, an instrument such as a catheter may be passed through its track and a tampon of gauze drawn after it. Wounds of the spleen may be sutured or the cut surfaces compressed by a figure of 8 ligature drawn over the protruding ends of a threaded needle, passed at right angles across the wound, or the gland may be removed. Wounds of the kidneys should be drained by gauze packing through an incision in the loin, or it may be best to do a nephrectomy. Wounds of the bladder should be sutured and the abdominal cavity flushed and drained; indeed, flushing and draining of the abdomen is indicated after all operations for the repair of traumatisms of its contents.

CHAPTER IX.

THE TREATMENT OF INTRA-ABDOMINAL LESIONS FOLLOWING CONTUSIONS OF THE ABDOMINAL WALLS.

Falls, kicks, blows upon the abdomen, and the passage over the abdomen of wagons, carts, etc., may result in simple contusion of the skin and muscles overlying the abdominal contents or else in injuries of the liver, spleen, kidneys, stomach, intestines, omentum, or bladder. Sometimes more than one of these is injured at the same time.

Rupture of the Spleen and Liver.—The diagnosis of a rupture of the spleen or liver, except for the symptoms of intra-abdominal hemorrhage and shock, is extremely uncertain. The location of the contusion, and the direction of the contusing force, taken together with some abdominal rigidity and special tenderness, localized over the area nearest the organ, is of value in establishing the diagnosis of rupture, provided there are symptoms of internal hemorrhage. In the absence of symptoms of hemorrhage they indicate simple contusion of these organs.

Rupture of the kidney is a very common accident and is usually recognized by shock, localized pain, and the passage of bloody urine. A localized tumor will not form if the rupture occurs directly through the peritoneal investment into the peritoneal cavity. If the rupture occurs so that the blood accumulates in the loose cellular tissue surrounding the kidney, a tumor forms rapidly, presenting first in the posterior ileo-costal space, enlarging downwards, forwards, and inwards. Urine may also extravasate in the same directions and even towards the surface. Cases in point:

I.—A driver of a patrol wagon was thrown off his seat and the wheel of this heavy wagon passed directly across the upper part of the abdomen. Within

six hours, besides the symptoms of shock, pain, tender abdomen, and bloody urine, a tumor was easily discoverable in each loin. These swellings lasted several weeks. After the first twelve hours there was a gradual rise of temperature, and this ranged from 100° F. to 103° F. for some days. The abdomen was distended and tender. There was an absence of some of the cardinal symptoms of peritonitis, especially those of a septic character; however, we were somewhat puzzled, and it was difficult to weigh the evidence. Later a fluctuating swelling appeared in the back on a level with the kidney areas. The greatest prominence of this tumor was in the middle line. I aspirated the swelling in the back and submitted the fluid to Dr. W. R. Lavender for examination. He reported:

"Specimen—Specific gravity 1015; reaction alkaline; color, yellow-reddish (V. Vogel).

"Centrifugal sedimentation.—Sediment blood red; microscopical; (1) large number of red blood corpuscles in rouleaux, some crenated, others distorted (poikilocytosis); (2) quite a number of leucocytes, polymorphonuclear principally; (3) a number of cylindroids. A quantity of amorphous urate crystals. R. B. C. and cylindroids, with an occasional hyaline cast, all of which are massed together by action of centrifuge.

"Diagnosis—Fluid principally composed of blood and serum with decided presence of urine in specimen."

This man recovered without suppuration, although his convalescence was tedious.

II.—A little girl, eight years old, fell, striking her right side against a dry-goods box. When seen a few hours later there was considerable shock, pain, and abdominal rigidity. A tumor was readily felt in the right ileo-costal space. At the end of twenty-four hours the symptoms so simulated a commencing general peritonitis that an incision was made in the upper quadrant to the right of the right rectus muscle. There was no peritonitis in spite of the pain, fever

103° F., abdominal distention, and muscular rigidity, but a large retro-peritoneal swelling (hematoma) was disclosed surrounding the kidney and separating the peritoneum along its lines of least resistance. The abdominal wound was sutured and an incision made in the loin, from which was discharged a quantity of blood and urine. A rent could be felt in the kidney. The wound was packed with sterile gauze to control a rather dangerous hemorrhage. The child recovered, although it was about a month before urine ceased to escape through the wound.

When a kidney is so lacerated that the hemorrhage accumulates in its pelvis the tumor is usually small and forms slowly, perhaps requiring several days before it can be detected. In such cases either the amount of blood in the urine is rather excessive or because of a blocking of the ureter by clots little or no blood is found in the urine. When the ureter is blocked or injured so as to prevent the escape of bloody urine into the bladder the tumor may enlarge quite rapidly, being similar in its action to an acute hydronephrosis. In one case operated upon recently all kidney tissue was destroyed in twenty-one days—the tumor filled the right side of the abdomen, occupied the false pelvis, passing at the level of the umbilicus and below into the left half of the abdomen. In this rare case the ureter was also enlarged, but not blocked, there being bloody urine in abundance. Both kidney sac and ureter were removed and the woman recovered. In another more recent case a similarly distended, though smaller, kidney was incised and drained with the hope of saving its functional activity,—sufficient time, two weeks, has not elapsed to determine the final result.* Other cases have been observed in which from the subjective and objective symptoms there could be no doubt but that the kidney was ruptured, but as a rule these people got well without any surgical interference. The writer has found the Harris instrument and Kelly

* This patient recovered with the functional activity of the kidney preserved.

cystoscope and ureteral catheters of great value in determining the source of a hematuria, as well as the functional integrity of both kidneys.

Fatal intra-abdominal hemorrhage may follow a rupture of the kidney, but this is an unusual result. In one of my cases a kidney was torn loose from its normal position. On post-mortem examination it was found in the pelvis anchored merely by its ureter. Strange as it may seem, this man lived eight hours after the fall, forty feet, which caused the injury. There were multiple fractures of the extremities complicating the abdominal injury.

Rupture of the Stomach and Intestines.—The most important intra-abdominal lesion following a contusion of the abdomen is a rupture of the stomach or intestine, because of the highly infectious nature of their contents. Unless recognized almost immediately or within a very few hours a fatal termination is almost inevitable. I know of no positively identifying symptom of this lesion unless it be (besides those common to other injuries mentioned) a more firmly contracted abdominal wall, thoracic breathing, early and continued vomiting. In case the stomach is ruptured there may be blood in the vomitus. The symptoms of peritonitis are quite positive and develop early, although distention of the abdomen may not appear until late, twelve to twenty-four hours. The writer recalls one case in which most of the symptoms were quite latent, not making themselves positive until the third day. The man died on the fifth day. On post-mortem examination a rent was found in the small bowel which had evidently been incomplete to begin with, but gradually enlarged so as to permit of a general peritoneal infection, in spite of an attempt upon the part of nature to wall off the injured bowel by means of a plastic exudate. Operation was refused.

Another case seen for the first time twenty-four hours after injury presented all of the symptoms of an approaching fatal termination, yet there was little distention. Death came six hours later. On post-

mortem examination, besides a rupture of the great omentum there was a complete rupture of the small intestine, with free leakage into the peritoneal cavity.

Paget says: "But is there no sign, within the first twelve or twenty-four hours after the injury, to tell whether the intestine is ruptured? Perhaps the most trustworthy signs are: (1.) the abdominal wall kept rigid and retracted; at no time soft or moving in respiration, but remaining rigid and concave for a day or longer, and then becoming distended. (2.) Persistent hiccough. (3.) No improvement in the patient's general condition at the end of twenty-four hours; the initial shock was perhaps not very severe, yet he does not rally from it. (4.) Some deep point of extreme tenderness. But these signs may be absent or uncertain; and Senn's test is not within the reach of everybody, nor always to be trusted. The evidence of internal hemorrhage is sometimes plain enough—the rapid increase of weakness, the rising dullness in one or both lateral abdominal regions; but the evidence of ruptured intestine may be sought most carefully, and sought in vain, till the patient is past saving by operation."

Retro-Peritoneal Rupture of the Intestine.—This very rare accident is indicated by shock, pain, early rise of temperature, and the rather rapid formation of an emphysematous, purulent, inflammatory swelling in either loin. This swelling may spread along the lines of least resistance, as any other compound inflammatory-gravitation abscess.

Rupture of the Bladder.—When the bladder is ruptured by reason of a contusion of the abdominal wall the determination of the character of the injury is usually simple. The history of the accident—the time intervening between the last urination and the time of the accident, which, if from five to eight hours, would indicate a fairly full bladder; and hence in a favorable condition to give away under a traumatism.

If the accident were immediately followed by well-marked shock and abdominal pain most intense over the bladder; if the patient were able to pass a small

quantity of bloody urine, or if upon introducing a catheter the surgeon could remove only a little bloody urine, the combined history and findings would prove almost to a certainty that the bladder had been ruptured. The injection of a measured quantity of sterile warm salt solution through a catheter into the bladder and this fluid immediately allowed to flow out and be measured will determine positively whether or no any, and how much, of the fluid may have escaped through a rent in the bladder. If the wound be intra-peritoneal and of large size, most of the salt solution will have passed into the peritoneal cavity. If the wound be intraperitoneal and of small size, most of the solution will return through the catheter. There will be very little pain when the warm salt solution enters the peritoneal cavity. When the wound is extra-peritoneal, there will be considerable pain produced by the forcing of the fluid into the extra-peritoneal spaces within the pelvis and under and above the pubes. If air be injected by means of a Davidson syringe through a catheter, it will, if the bladder be intact, produce a circumscribed tympanitic tumor above the pubis. If an intra-peritoneal rupture is present, the air will enter the peritoneal cavity and its presence can be determined by an increasing tympany. When the rent is extra-peritoneal, the injection of the air is painful, and its presence outside the peritoneum can be determined by emphysema of the suprapubic and pelvic cellular tissue. When the wound is both intra- and extra-peritoneal, the symptoms of intra-peritoneal rupture will predominate, as there is little resistance offered to the escape of the urinary secretion into the peritoneum. Of course, if the extra-peritoneal rupture is large and the intra-peritoneal rupture very small, the reverse will be the case. When a rupture of the bladder is both intra- and extra-peritoneal, there is but one wound (sometimes stellated), the boundary line between intra- and extra-peritoneal being the nearly horizontal line of reflection of the parietal peritoneum onto the bladder.

Usually twenty-four to forty-eight hours after an

intra-peritoneal rupture symptoms of peritonitis develop and death follows. If, however, the urine and urinary passages were normal prior to the accident and no infection is introduced by means of a catheter, sterile urine will enter the peritoneal cavity and there will be no peritonitis.

In one of the writer's cases one gallon of urine and some clots were removed from the peritoneal cavity five days after the accident. There was no peritonitis. Extra-peritoneal rupture is almost invariably followed by a dangerous suppurative cellular inflammation involving the suprapubic and pelvic retro-peritoneal spaces. Should the patient survive long enough and the inflammatory products not be evacuated by art or nature, they will extend to the anterior wall of the abdomen.

TREATMENT.

The few illustrative cases given have been introduced merely as aids in building a framework upon which to construct a rational practice in the medical and surgical treatment of the class of injuries under consideration. If the diagnosis as to the parts involved, and the extent of injuries and their anatomical relationship to the peritoneum, could be positively established, treatment, immediate and secondary, would involve little indecision. Of these things it seems there can never be more than uncertain deductions, because the premises are only relatively reliable. Yet we may formulate certain rules of practice in the management of cases of injury to internal organs following contusions, etc., of the abdominal walls, but these rules must be subject to modification by future knowledge.

Liver and Spleen.—When from the symptoms of shock, localized pain, and internal hemorrhage it appears that either the liver or spleen have been ruptured, no operation should be done, *unless* the progressive character of the symptoms of internal hemorrhage indicate a probably fatal ending. Opium and ergot can be used with benefit, and the chest and ab-

domen on the side of injury immobilized by an adhesive plaster splint. The local use of ice may be helpful. If an abdominal section is done, this should not be delayed as a primary or secondary procedure beyond the time when a favorable termination may be hoped for. Operations which in themselves are serious should not be undertaken upon moribund patients. To perform a tracheotomy upon a patient about to die from suffocation is praiseworthy and a duty. An abdominal section done upon a patient in like condition from a grave intra-abdominal lesion, the accurate repair of which, even under rather favorable circumstances, requires much time and manipulation, is a mistake.

A bleeding mesenteric artery can, if recognized, be quickly controlled. In like manner a ruptured ectopic pregnancy can be managed, but staunching the hemorrhage from a ruptured liver or spleen is quite a different proposition. (1.) The introduction of stitches, with or without gauze packing, is indicated in rupture of the liver. (2.) For a like condition of the spleen, the same technique given for stab wounds of that organ are to be followed, viz., they may be sutured or the torn surfaces compressed by a figure-of-8 ligature drawn over the protruding ends of a threaded needle passed at right angles across the wounds. The abdominal wound would under this procedure have to be treated on the "open" principle, with gauze packing down to the injured spleen. (3.) The gland may be removed.

Kidney.—(1.) Rapid intra-peritoneal hemorrhage from a ruptured kidney should be treated by immediate resort to a right-sided abdominal section, ligation of the renal vessels and removal of the injured organ.

(2.) *Retro-peritoneal rupture* of the kidney with the formation of a tumor is usually best treated upon the expectant plan as regards surgical interference. Ergot, opium, and turpentine should be given internally. Experience seems to show that the bowels should be kept quiet, because of the intimate relations of the

colon to the kidneys. Disregard of this point has been known to bring about a recurrence of renal hemorrhage. The local use of ice is beneficial.

(3.) *The development of sepsis* following a retro-peritoneal rupture of the kidney requires a post-peritoneal incision for the establishment of drainage.

(4.) *Life-threatening hematuria*, the result of an injury to a kidney, demands nephrectomy by the lumbar route.

(5.) *A complete or partial rupture of a ureter* should be treated by an attempt to repair the ureter through a retro-peritoneal opening. Failing in this a nephrectomy should be carried out by carrying the incision upwards.

(6.) *Rupture of a kidney*, followed by an accumulating hemorrhage into its pelvis, should be treated (1) primarily like an extra-peritoneal rupture; (2) an extra-peritoneal incision into the kidney should be made for the purpose of relieving the pressure and threatened renal atrophy, unless within ten days or two weeks there are positive signs that the tumor, if large, has ceased to increase and has begun to decrease in size. This practice is warranted because in one of my cases complete destruction of all kidney tissue resulted, from overdilatation, in twenty-one days. (3.) It may be necessary to (a) attempt to obliterate a degenerated kidney sac by an incision and drainage, or (b) its complete extirpation may be advisable should the patient's general condition warrant such an undertaking.

Stomach and Intestines.—(1.) If the symptoms, as before pointed out, cause even the suspicion of rupture, we should be ready, upon the first warning that our suspicions had some *good* foundation, to resort to an immediate abdominal section for the repair of the injury and the cleansing of the contaminated peritoneal surfaces. (2.) Whenever the diagnosis of rupture is probable or humanly sure no time should be wasted before operating.

Bladder.—(1.) An intra-peritoneal rupture of the bladder must be treated by an early abdominal sec-

tion for the purpose of sewing up the wound in the bladder, and for the cleansing, by thorough irrigation, of the peritoneal sac. Drainage should be employed if there are evidences of peritonitis. (2.) Extra-peritoneal rupture requires a median suprapubic, extra-peritoneal cut for drainage. The wound into the bladder may be sutured in part with an absorbable suturing material, but usually this is not advisable. In every case a rubber drain should pass into the bladder and gauze packing lightly introduced into the prevesical space. If there has been such extravasation as not to be relieved by a median incision others are demanded where they will do the most good. Perfect drainage must be established.

A *combined intra- and extra-peritoneal rupture* should be treated by a combination of the practice given above.

CHAPTER X.

SPRAINS AND CONTUSIONS OF JOINTS.

Wounds of joints are conveniently divided into two general classes: 1. Simple; those in which the skin overlying the joint is unbroken, or if so, the wound is only superficial and does not penetrate the joint proper. 2. Compound; when not only is the skin wounded, but the wound extends through the tissues *into* the joint.

The first class of injuries are designated as *sprains* and *contusions*, and embrace almost all injuries not accompanied by a permanent displacement of the articular surface, or a disorganization or serious breaking up of the bones and their cartilages going to form the joint.

Sprains result from indirect violence; the muscles guarding the joints being relaxed or caught unawares by some unexpected act, as a false step. Any violent twist which results in moderate or severe movements beyond the normal limitations of function stretches or tears the capsule, synovial membrane, and ligaments to a degree depending upon the violence exerted. The symptoms of a sprain are those common to injuries in general, viz., pain, swelling, and interference with function. Except in the mildest kind of sprain, the pain is intense immediately upon receipt of the injury. Swelling occurs rapidly and is due to the accumulation of synovial fluid within the joint cavity as well as the accumulation of blood and exudative fluids from the torn and irritated blood-vessels without the synovial sac. Not infrequently the synovial fluid is mixed with blood. Swelling usually reaches its maximum during the first twenty-four hours. The acute pain experienced on receipt of the injury is gradually changed into numbness, which, however, is immediately replaced by agonizing pain upon any attempt at motion of the joint; especially is

this so when ligaments have been torn. In such cases pain on pressure is most severe over the points of insertion of torn ligaments which usually give way at these places, sometimes stripping or chipping off small pieces of periosteum or bone with them.

Prognosis is uncertain, depending in the main upon proper recognition of the importance of the injury and an intelligent application of the aids of surgery to the restorative powers of nature. At best, many sprains are only imperfectly recovered from because the nature of the injury itself so changes the delicate complexity of the joint that a return to the normal is impossible. Fibrinous adhesions may form because of the hemorrhage into the synovial sac. The injuries to the capsule, ligaments, and tendons belonging to or crossing the joint may result in such permanent thickening as to absolutely eliminate the natural strength and motion of the injured joint. Sometimes, although there is no visible change in a joint after apparent recovery from a sprain, special points of tenderness may be discovered; the surface may be abnormally cold and the joint somewhat, often quite, stiff and painful when used.

Treatment.—This should be directed towards relieving the pain, modifying the swelling, and hastening absorption of the traumatic exudate into and surrounding the joint; at the same time placing lacerated and torn tissues into the most favorable condition and position for rapid repair.

More relief from pain can be obtained by the employment of heat than cold, and the practice is more agreeable to the patient. The writer usually in all cases of sprain, when seen within a short time after an accident, advises the long continued and frequent immersion of the injured joint in water as hot as can be borne. It is still better to add one tablespoonful of mustard powder to each gallon of water. This kind of heat relieves pain, lessens hemorrhage and irritative exudate within and surrounding the joint. The preliminary treatment may be kept up during the first eight to thirty-six hours. In the intervals be-

tween the immersions, the joint should be surrounded by a copious quantity of cotton wool held in place by a bandage applied sufficiently tight to give support, but not to cause pain. The joint should be elevated so as to favor the return circulation of the blood. After the end of the first twenty-four to thirty-six hours, all swelling, the result of the injury, has taken place. The object of treatment at this time is to hasten absorption of the fluids causing the swelling and at the same time prevent all irritation tending to keep up a pouring out of blood and fluid exudate from torn and dilated vessels. Gentle massage and frictions with an avoidance of passive motion is valuable, and at this time also some pressure may be employed by means of a flannel bandage laid over a little cotton wool. As the swelling begins to disappear, the massage may be made more vigorous and very gentle and moderate passive motion begun. Should this more active treatment be followed by continued pain, it should be abolished and massage and the bandage relied upon until most of the swelling has disappeared. At this time, varying in length from five days to two weeks after receipt of the injury, two lines of practice may be employed; the one only applicable when there has been no extensive tearing of ligaments and capsule; the other being the only rational practice if such injury has taken place. If, upon moderate passive motion after the swelling has gone down, there is no considerable reaction, the indication is to give support and then allow of a moderate and gradually increasing use of the joint. Support can be obtained by using a flannel bandage, or better still, a more permanent and reliable dressing is made from adhesive plaster put on so as to make even pressure, admit of limited motion, but not to constrict and interfere with the return circulation. Adhesive plaster dressing can also be used with decided advantage as a primary dressing in sprains of moderate degree where there is little tendency to swelling. When rather active or violent reaction follows passive motion, the joint should be immobilized by plaster of Paris until repair of torn

tissues has taken place. In ten days to three weeks, the plaster of Paris can be removed and massage with passive motion renewed and a gradual use of the joint allowed. Some form of support should be worn for a considerable period after beginning the use of a joint that has been sprained.

Contusions of joints follow falls, blows, or kicks. They may result in a mere bruising of the overlying joint structures or in subcutaneous tearing of not only some of these tissues, but also of the joint capsule and synovial sac; even bruising of the cartilages themselves. Hemorrhage around or into the joint accounts for most of the swelling in these cases. Treatment is by hot fomentations, pressure, and massage. Anti-septic incisions for the evacuation of effused blood may be employed with advantage in rare instances of large extra-articular blood accumulations. Aspiration may also be of advantage in a very small number of intra-articular blood and synovial accumulations. Both practices to be of advantage should be done early.

PLATE III.
ADHESIVE PLASTER DRESSING FOR STRAINS OF THE ANKLE-JOINT.



APPLICATION OF FIRST LAYER OF STRIPS.

Strips of adhesive plaster, $\frac{1}{2}$ in. to 14 in. wide and 12 ins. to 18 ins. long, according to the size of the extremity, are applied along either side of the lower third of the leg, passing under the heel. The first strip must be applied closely to the edge of the tendo Achillis. After passing under the heel the strip is made to cross the sole of the foot, terminating at the base of the great or little toe. Several of these strips are applied so as to cover in either the inner or outer side of the ankle.

PLATE IV.

ADHESIVE PLASTER DRESSING FOR SPRAINS OF THE ANKLE-JOINT.



APPLICATION OF SECOND LAYER OF STRIPS.

Strips are applied in an ascending fashion, the first having its middle at the point of the heel, the ends being carried to the bases of the metatarsal bones. *The strips should not meet in front and make circular constriction.*

CHAPTER XI.

COMPOUND WOUNDS OF JOINTS.

Compound wounds of joints are often among the most serious injuries the surgeon is called upon to treat. The seriousness of these traumatismis depends upon two conditions: (1) Whether or not the inflicting instrument is free from contamination by inflammation producing germs; (2) the size of the joint injured and the extent of the injury.

Small puncturing instruments, such as shoemakers' awls and the like, when in constant use are apt to be free from germs, and punctures into joints made by these instruments are not infrequently followed by mild consequences. Especially is this likely to be so if the instrument does not enter the skin directly over the joint, but at some distance away, or in an oblique fashion. Ice picks, axes, and other cutting tools used in cutting, storing, and distributing ice often make wounds of joints which, although sometimes ragged and extensive, are aseptic. Most any kind of instrument capable of wounding a joint may produce an aseptic wound, but the presumption is that all wounds into joints, except those made by a careful surgeon, are apt to be followed by infection of the joint. Wounds of small joints are not of much moment as to danger to life, and if the trauma is not great, the usefulness of these joints ought to be, in part at least, restored.

Wounds of the joints of the upper extremity which do not seriously damage the component parts of the joint structures are not primarily threatening as to life or future usefulness of the joint, although, of course, the function of the joint may be impaired. It is hardly conceivable nowadays that as a result of such an injury amputation would be called for: rare exceptions will be met. But wounds into the main joints of the lower extremity are sometimes dangerous as to life, and often function is most seriously impaired, amputation being occasionally required to

save life. The seriousness of gunshot wounds and compound dislocations and fractures into joints depends in great measure upon the size of the joint and the amount of injury, not only of the component joint structures, but also the extension of the injury to the upper and lower ends of the bones going to form the joint. Greater than all, it must be acknowledged that the future behavior of every compound joint injury depends upon the degree of cleanliness employed at the first dressing.

Symptoms.—The escape of clear or blood-tinged synovial fluid is diagnostic of joint wound, but in some cases of punctured wounds no synovial fluid escapes, and it is practically impossible to say whether or not the joint has been opened. To determine this question it is best to wait for a rapidly supervening secondary symptom of joint puncture, i. e., swelling. The degree of swelling will depend upon the amount of trauma within the joint and the activity of any germs introduced. Slight or no elevation of temperature will mark the absence of infection. A probe should not be used for diagnostic purposes, because, although the instrument be aseptic, in its passage it might force into the joint infectious germs or germ-bearing material which in the passing of the inflicting instrument had been left on the way-side without the joint. In open wounds inspection is often all that is necessary to determine that a joint has been injured. The eye should be aided by the aseptic finger in determining the extent of injury in such cases.

In infected compound joint injuries of all kinds, which have been infected and brought under observation too late for correct primary treatment, acute septic inflammation follows in the form of abscess within and often without the joint. The joint is swollen, red, hot, and painful. As the flexed position allows of easiest relaxation and accommodation of effused fluids, nature brings it into this position and the patient resists and complains of excruciating pain if any attempt is made to change the position. After

the inflammation has lasted a number of days, or perhaps a few weeks, the parts of the joint other than the synovial membrane may be attacked, the cartilages become eroded and the ligaments infiltrated and in part destroyed. The infective process may extend above and below the joint involving the bones, and pus travel along the lines of least resistance between the intermuscular planes. There may be great swelling of the limb due to this cellular inflammation. In moderately extensive compound injuries this extending inflammation may begin early, because the injury opens up the avenues for infection. If the openings, however, happen to be favorably located to favor drainage, the inflammation may remain local until the avenues for discharge become blocked up by accumulating discharges and inflammatory swelling. Spasmodic jerking of the muscles crossing the joint is a symptom of extension of inflammation to the cartilages. This is more marked during sleep, because the patient is "off guard." This jerking causes agonizing pain and patients are apt to awake with a cry denoting great suffering. The septic absorption, pain, and interruption of rest and sleep produce great exhaustion; the pulse becomes fast and compressible; the temperature ranges high, the tongue is dry. Now should nature or art establish good drainage, all bad symptoms may gradually subside and the patient recover with a more or less damaged and deformed extremity. On the other hand, pyemia may develop, or septicemia and the exhaustive drain cause death.

The approach of these dangerous conditions is marked, in pyemia, by sweating, irregular chills, and elevation of temperature. Such a condition calls for careful subjective and objective examination of all parts of the body. The writer has seen death from pyemia result in less than two weeks after a compound injury to a joint. Exhaustive sweats, emaciation, red cheeks, diarrhea, continued fever of from 1° to 4° F. elevation; increasing frequency and loss of tone of the pulse; too rapid respiration; restlessness, sometimes drowsiness; scanty, high colored, usually

albuminous, urine. All these are the forerunners of a fatal termination. They must be recognized early for favorable treatment.

Treatment.—Punctured wounds of joints should be treated upon the antiseptic expectant plan. The skin covering the joint should be thoroughly cleansed with soap, water, and a brush, washed in alcohol and afterwards in a 1-1000 solution of bichloride of mercury in water. An antiseptic dressing is then applied and the joint placed at rest upon a splint. Should the temperature remain down and the evidences of local inflammatory trouble be moderate, nothing more will be required. If, however, the constitutional and local symptoms indicate infection, no time should be lost in making a free antiseptic incision, or incisions, into the joint. Copious irrigation (bichloride 1-3000) should be employed in such a way as to reach every recess of the joint. Drainage tubes should now be introduced and the limb enveloped in heavy moist antiseptic dressings.

The joint should be placed at rest upon splints and elevated, perhaps using the weight and pulley in order to prevent irritation of joint surfaces by muscular spasm. The local application of cold by packing in ice is of great value in controlling inflammation. The cold does no injury and undoubtedly inhibits germ activity. To be of service it should be applied around the antiseptically dressed joint in much the same way as ice is packed around the can of an ice-cream freezer. The Leiter coil and similar appliances are tinkering tools in such cases. Continuous antiseptic irrigation with ice cold fluid is often of great value. In extensive injury use the same plan of treatment, that is, painstaking antisepsis, irrigation and drainage, antiseptic dressings.

Amputation should never be thought of in civil practice unless the vessels, nerves, and tendons crossing the joint are so damaged that repair with usefulness is out of the question. Atypical or even typical resections may be done. It used to be thought that primary amputation was required in gunshot and other

lacerating and destructive joint injuries. Since expectant antiseptic drainage with immobilization, practiced first by Langenbeck and other German surgeons during the war with France have given most satisfactory results, the surgeon of to-day would hardly be justified in amputating as a primary procedure. If in infected joints the line of treatment indicated does not succeed,—and it may succeed even after wide suppuration, if only the drainage through all infected tissues be made ample and maintained until repair is well established,—then amputation ought to be considered and not too long delayed. Pyemia may be checked by extensive incisions into and above and below the primary focus. Secondary collections must be opened and drained early. Amputation may be done, but if at all, it must be done after secondary foci have been detected and drained, and the incisions into and around the joints have proven insufficient to check infection. When hectic fever threatens destruction by exhaustion, amputation is imperative.

How to Amputate.—The patient should be freely stimulated by strychnia and alcohol and a rapid operation performed under as short and not too profound anesthesia as possible. The main vessels should be tied and oozing prevented by proper sponge packing and bandaging. Few or no stitches ought to be introduced. If the shock of the operation is sustained, recovery is usually assured. The writer has been surprised how wonderfully recovery has followed among the apparently hopeless cases of septicemia of the kind under consideration which at his hands have been treated by amputation.

Heart stimulants, alcohol, and easily assimilated, perhaps predigested food, should be given; sponging of the surface, copious draughts of water, all aid in carrying the treatment of these cases to a successful termination. The employment of antistreptococcus serum would be useless in chronic cases, but might possibly be an advantage in the early periods of acute infection; but here, as elsewhere, treatment should be directed towards prevention and limitation by removal of the cause of infection.

CHAPTER XII.

HEAD INJURIES.

Scalp Wounds.—A common impression prevails that scalp wounds differ much in their behavior from wounds in other localities, and therefore special rules of treatment are necessary. This is not so; all that is essential is a recognition of the anatomical peculiarities of the part and the care demanded to render the wound area free from germ-carrying materials. Some scalps are loaded with oil, dirt, and epithelium, and, when wounded, require more than ordinary efforts to disinfect; however, a vigorous use of soap and water, alcohol, and bichloride solutions, *employed in the order named*, will disinfect efficiently. It is usually wise to cut away the hair in the immediate vicinity of a scalp wound, and in all complicated cases, a large area, perhaps the whole scalp, should be shaved and then thoroughly disinfected.

Incised Wounds.—Hemorrhage should be treated as elsewhere, only it must be recalled that the rather broad and firm surfaces cannot bleed much if approximated by suture; hence few ligatures are required. After preparation, incised scalp wounds should be treated as skin wounds in other parts. Silkworm gut is the best suturing material, and the stitches should be introduced sufficiently close together to bring about accurate approximation, but not so close as in deep skin wounds in most other parts, where it may not infrequently be good practice to use superficial as well as through and through stitches.

The simplest wounds may be dusted with some protective drying powder without an overlying dressing, but as a rule the same practice as to the dressing of wounds in general should apply to scalp wounds. Stitches can be removed in from four to six days.

Scalp wounds resulting from falls, blows with clubs, canes, beer bottles, and the like, often resemble very much the ordinary incised wounds, only that they are

apt to be irregular and the edges present a slightly-contused appearance with a tendency to eversion. Such wounds require the same kind of treatment as incised wounds proper. They may be very extensive, especially when due to the head, or in women the long hair, being caught between or in moving machinery. Large parts of the scalp have been torn off the skull or flaps of considerable size lifted up. In the former case, an attempt should be made to suture the detached scalp in place with the hope that union will occur; this failing in whole or in part, repair of the raw surface may be aided, after granulation has been established, by skin grafting. Flaps should be sutured carefully, and almost invariably it will be found that they will unite because of the abundant blood supply.

When a scalp wound is complicated by a deeper injury through the aponeurosis of the occipito-frontalis muscle, opening up channels for infection between the muscle and the pericranium, it is unwise to use stitches at all if the wound is a small one, and if a long one, only a comparatively few stitches ought to be introduced, the reason being that if our efforts at disinfection have not been successful avenues of escape for the products of infection must be free, because septic inflammation of a most dangerous form may occur in the cellular tissues overlying the pericranium, and this infection invade the skull through the numerous veins connecting with the meninges, causing either an intracranial abscess or a suppurative lepto-meningitis; therefore, such wounds should not be tightly closed by suture, but they should *invariably be drained*. In case infection of the kind under consideration has taken place, the original wound must be reopened immediately; perhaps other openings may be required to establish free drainage. If a decided betterment, both in the local and constitutional condition (not infrequency of an alarming type), does not follow within a few hours at longest, the skull should be carefully inspected under and in the area nearest about the original injury, and it may be that pus will be detected coming out of one or more of the numerous openings

connecting the exterior with the interior. Such a condition would probably demand the use of the chisel or trephine in order to limit or prevent by disinfection and drainage a fatal intracranial affection. Of course, if there are symptoms of mischief within the skull determinable by known means of cerebral localization, the chisel or trephine should be used over the recognized area, not forgetting, however, that that part of the skull immediately under the seat of primary injury, and where the greatest intensity of inflammation began, is the most likely portion for attack by the surgeon, who should not be lured away by symptoms seemingly pointing in other directions, unless they are of a positive kind. In acute intracranial inflammatory conditions many of our usually reliable localizing symptoms are untrustworthy.

Contusions of the scalp are common and result from the same class of injuries as scalp wounds following blows, falls, etc. In the majority of cases the swelling resulting from blood extravasation and exudation is limited and of little importance; all that is necessary in the way of treatment being the application of very hot fomentations. Cold is a favorite remedy with many surgeons, but the writer's preference is for moist heat. If, as not infrequently happens, the patient complains of pain and a "hot, burning fever" in the head, the application of cloths wrung out of ice water or the use of the ice cap is most grateful.

Sometimes quite extensive hemorrhage occurs under the scalp, causing large fluctuating swellings, which, fortunately, gradually disappear under the form of treatment just recommended. It is a good rule never to incise these swellings unless there are both local and constitutional signs of infection in the swelling, then free incision, antiseptic irrigation, and the establishment of drainage are demanded. Occasionally a form of swelling following contusions of the scalp is met with which presents puzzling features to the young surgeon, and not invariably is the elder certain as to its meaning when perchance the sufferer may have received such a blow as to shake up his cere-

bral balancing powers to a degree that rather indefinite "brain symptoms" more than suggest the possibility of skull fracture with compression of the brain. This form of swelling is caused by hemorrhage under the pericranium. It is a circumscribed swelling and is limited between the sutures of the bones which it covers. Because of its exposed position, the parietal eminence is a favored seat for this swelling, which at first is soft in character, but soon assumes hard elevated borders, the central portions remaining soft. It is this ridge-like border which causes misgivings. To the fingers examining this edge and the soft center, the sensation of fracture of the skull with depression may be experienced. But when it is remembered that the edge of the swelling is raised above the bone outside the area of injury, and also that by firm pressure with the finger or some non-cutting instrument the border can be indented, of course the idea that fractured bone is being felt must be abandoned. The indurated border is due to a fibrinous exudation.

Swellings under the scalp are found in new born babes and result from difficult labor with or without instrumental interference. Mild forms of this swelling are extremely common and excite no comment, but the severer forms, especially the sub-pericranial variety, invariably cause great anxiety and apprehension upon the part of parents and family. The busy and inquisitive neighbor may stir up considerable of a rumpus if the attending physician does not quiet matters by an explanation and favorable prognosis. He should not fail to mention incidentally to some relative that in rare instances the brain is injured by the compressing force of the difficult labor, but as far as the external swelling is concerned, it is of little moment, and will disappear in a few days or a week or so. The treatment is as for ordinary contusions.

TREATMENT OF COMPOUND FRACTURES OF THE SKULL.

Every compound fracture of the skull vault, with or without depression, in which there are brain symptoms other than those of a most transient character due to contusion (concussion) of the brain, should be

submitted to operative interference. Where there are symptoms of compression of the brain with slight or no evidences of depression of bone, the skull should be trephined, and almost invariably one of two conditions will be met with, either a clot will be found between the dura and the skull (sometimes or more rarely beneath the dura), or a fragment of the internal table will be recognized which is either depressed so as to push the dura down or, having torn through the dura, penetrates the brain.

Every depressed fracture of the skull, simple or compound, with or without brain symptoms, should be trephined and the depressed bone elevated. In every case where clots are found they should be removed, and, unless an accurate hemostasis is obtained, drainage should be established. In every case of trephining, no matter for what purpose, if there is the slightest suspicion that absolute asepsis may not follow in the primary repair of the *deeper parts of the wound*, drainage should be provided for, the drain passing to the deepest part of the wound. A dependent skull opening may be essential for the establishment of good drainage.

The first essential procedure in the management of a compound or depressed fracture of the skull is the shaving of the entire scalp and its sterilization by the most painstaking use of antiseptics. The wound itself should be washed with antiseptics, but just before the beginning of the operation the wound and scalp in its immediate neighborhood should be irrigated and sponged with normal salt solution, as it is desirable that no irritant of a chemical kind should come in contact with the brain or its membranes during the operative procedure. Chloroform should be the anesthetic of choice. Sterile towels must be arranged so as to protect the wound, special pains being employed in the arrangement of the towels so that the operator and assistant will not by chance touch the patient's face, the chloroform mask, or the anesthetizer's hands. If the patient is brought to the surgeon after infection of the scalp wound has occurred.

PLATE V.



The Esmarch tourniquet applied. Position of the anesthizer, etc., in an operation for compound fracture of the skull. (From a patient in the Clarkson Hospital.)

not only the edges of the cut or torn scalp must be sterilized, but the whole wound area, including the bone surface. To do this it is best to elevate the wound flaps and after irrigation and the removal of all foreign materials, to pour carbolic acid, 95 per cent., into the wound, swabbing this about in every recess by means of a piece of sterile gauze held in a suitable forceps, washing the acid out within a minute or two with alcohol. The wound is then irrigated with a corrosive sublimate solution, followed by a normal salt solution; it is now in a condition for the operator to attack the deeper parts without the fear of carrying the infection from the more superficial structures.

There is absolutely no danger in using carbolic acid in this way, its entrance between all fissures to the bottom of the infection is a safeguard. Numerous practical experiences have proven the safety and advantages of the use of the antiseptics advocated. There may be others as useful, but with them the writer has never been able to handle his own cases so successfully, and he feels quite capable of forming an opinion if a wide experience and extended opportunities for becoming practically acquainted with the work of others means anything.

In order to keep the field of operation free from flooding of blood from any incisions made through the scalp, either chain ligatures may be used, or, better and simpler, an Esmarch tourniquet can be applied around the head, crossing over the eyebrows and under the occipital protuberance. This bandage should not be removed until after the operation has been finished, and the superficial dressings applied and held against the wound by an assistant's hand. The work is completed by the application of a sufficient antiseptic dressing held in place by a smoothly adjusted recurrent bandage.

CHAPTER XIII.

POISONED AND DISSECTION WOUNDS.

Poisoned wounds may be defined as a class of infections resulting from microbic, chemic, or mixed biochemical infection, having certain special well recognized characteristics which vary in many respects, both etiologically and in their clinical course, from wounds as met with in every-day accidental and operative surgery.

Post-Mortem or Dissection Wounds.—An increased knowledge of the pathology of diseases and a better appreciation of the means at our command to prevent or control infections has diminished the frequency with which post-mortem or dissection wounds are met with, which give rise to symptoms of importance. A poisonous substance developed in a dead body may enter through a prick, cut, or abrasion, and cause either a local inflammation or a rapid, more or less general blood poisoning. The poison, if derived from bodies of individuals recently dead, is more virulent than from those in the more advanced stages of decomposition, and in general it may be stated that the more decomposed the body, the less the danger. It must be remembered, however, that Pasteur proved that certain diseases of animals (found in man also) could be contracted by healthy animals grazing over ground in which was buried the bodies of animals long since dead from these same diseases. Certain specific diseases can be inoculated from the bodies of individuals dead with these diseases.

Bodies dead from diseases such as erysipelas, septic peritonitis, and more especially the puerperal type are responsible for many of the most serious cases of post-mortem wounds met with; and inoculation from the living through the injured skin of the surgeon while engaged in examining or operating upon patients suffering from these infective diseases may cause the most serious mischief.

It is said that inoculation may take place through the unbroken skin, entering through the hair follicles, etc., but this is theory. No man who is actively engaged in using his hands in medical and surgical work can be sure that there may not be one or more abrasions or other minute passageways for microbic or bio-chemical poisoning. Ordinary ocular inspection may not disclose these channels, but they are present just the same from time to time.

Sir James Paget (Clinical Lectures and Essays) says: "For not all men can be made ill by a virus from a dead body, nor can the same man be made ill at all times; but there must be what is called a fitting soil for the virus to work in. We know no more what this soil is than we do what the virus is; we have to use figurative expressions; but we need not doubt that they imply facts, and that for any living body to be made diseased by a dead one, there must be certain living materials which can be diverted by the dead ones from their normal relations and turned into a morbid course."

Two facts have been well recognized: First, a person whose duty calls him to make frequent post-mortem examinations can become almost immune against post-mortem poisoning; his system becomes protected against the virulence of poisons; second, a debilitated state of the general health predisposes to infection. The writer has seen many cases of infection of the hands among butchers, cooks, and dish-washers, but these infections were almost without exception local in character and no death or dangerous constitutional conditions are recalled. Some of these people were quite ill and a few suffered serious local infections, but as the animal material handled by these people was from healthy sources, virulent poisoning was not to be expected.

Types of Post-Mortem Poisoning.—Local.—As a result of constant local irritation of the hands by the juices of dead bodies a form of wart is met with which is somewhat analogous to the venereal warts caused by gonorrhea and is described by Stanley Boyd as

the "Dissecting porter's wart." It results from irritation and not infection, and is found upon the dorsal surfaces of the hands and fingers. There is no ulceration, but there may be cracks and fissures. The multiplicity of the warts distinguishes them from epithelioma.

An annoying, but not dangerous, form of local infection is often found upon the hands of students engaged in dissection and sometimes also upon the hands of physicians who not infrequently make post-mortem examinations. It consists in one or several pustules which develop upon the dorsum of the fingers and seem to select by preference the knuckle areas. These pustules are sometimes found upon the dorsum of the hands, wrist, and lower fore-arm, and when found in these latter localities, usually take on the characteristics of small boils with perhaps rather extensive inflamed circumferences. Whether pustular or furuncular in kind, they tend to be quite chronic, and unless treated after an especial fashion, ulcerating surfaces form beneath the scabs of their dried secretions. Inflammations of a very chronic kind are also found around about and under the nails, the result of local post-mortem infection.

Treatment of Local Infection.—Warts are successfully treated by the use of caustics, and for those who must continue to expose the hands to irritation this is the best treatment. The caustic must not be too powerful and perhaps glacial acetic acid applied every day or every second day is the best. It is said that the constant use of extract of belladonna is curative. When radical means are desired, the warts should be removed with the scissors, the bases curetted, and to the raw surfaces pure carbolic acid applied. If the warts are numerous, the action of the carbolic acid may be limited and pain much modified by mopping the cauterized surfaces with alcohol. A wet antiseptic dressing should be used and the probabilities are that repair will soon take place. A boracic acid ointment dressing may be used with advantage as repair progresses. In some obstinate cases it is neces-

sary to repeat the carbolic acid and alcohol applications. Where fissures and cracks complicate these cases, the carbolic acid should be made to reach the bottoms of these separations. The pustules may be treated by opening them thoroughly, applying carbolic acid, and then a wet antiseptic dressing, or the pustules may be curetted out and then apply the acid and dressing; but it must be remembered that success in treatment depends upon the prevention of the accumulation of the irritating pus beneath scabs or dried dressings. Local inflammatory conditions involving the nails are types of purulent onychia. Suppuration takes place around about and also beneath the nail. The matrix will be affected in whole or in part and as a consequence a part or all of the nail is loosened from its bed. The matrix is converted into granulation tissue. The condition is a painful one and apt to be slow in its repair.

In the early stages, the tissues around the nail, usually on one side, ought to be incised and pure carbolic acid or nitrate of silver stick applied to the cut surface. As soon as it is clear that suppuration has or is about to occur under the nail a piece of the nail should be cut away and the infected surface beneath touched with carbolic acid. Wet antiseptic dressings ought to be used. *Hot* fomentations are grateful. In spite of prejudice by the profession, the patient will appreciate and be grateful for a hot, *thick* flax-seed meal poultice, mixed up by using a moderately strong solution of carbolic acid or bichloride of mercury.

The constitutional effects of post-mortem wounds are produced by the entrance of poisons, microbic, chemical, or both, into the circulation, usually through the lymphatic system. The severity of the symptoms depends upon the amount and character of the poison absorbed, as well as the individual susceptibility.

A *septic lymphangitis* makes itself evident usually within twenty-four hours after inoculation,—there is pain and throbbing of the fingers and possibly arm. In a few hours red streaks may be observed running

towards the nearest glands. If the infection is limited to the main lymphatics, these red streaks are isolated, otherwise all the lymphatics become involved and a more or less diffuse cellulitis develops and softened areas can be felt. In the isolated type of lymphangitis the spread of the poison seems to be in a measure arrested by the glands along the course of the lymphatics. These glands, in order from below up, become swollen and painful and may suppurate. Diffuse suppuration of the axilla and even pectoral region may occur.

Constitutional symptoms may be profound; high temperature, delirium, and marked depression is observed. Death occasionally follows this poisoning in from two to four days. Every post-mortem wound should be encouraged to bleed, and if there are no cracks upon the lips, it ought to be sucked. This will remove some, if not all, of the poison. The wound should then be cauterized with glacial acetic acid or carbolic acid, both of which drugs should always be at hand when post-mortem work is being conducted.

Simple isolated lymphangitis requires little treatment except the antiseptic treatment of the point of inoculation. Hot fomentations, painting along the lymphatics with tr. iodine, or extract of belladonna and glycerine may possibly do some good.

Suppurating glands should be incised and all forms of cellulitis treated upon the principles already laid down. Drainage and supporting constitutional treatment are the keys to success.

Insect stings and bites usually require no special treatment further than the local application of dilute ammonia water or spirits of camphor. If many bites have been received at the same time and these are clustered, there may be considerable swelling. Constitutional symptoms resulting from the absorption of the acid poison of stings and bites are in rare instances characterized by a general depression sufficient to demand energetic treatment. Actively diffusible heart stimulants must be given internally and

by hypodermic medication. When an insect sting or bite is followed by severe local inflammatory signs, together with constitutional symptoms indicative of sepsis, it is presumable that a mixed infection has occurred, viz., a chemical poisoning from the sting or bite combined with a microbic infection. If the sting has been broken off and left in the skin, it should be removed. In any case simulating a poisoned wound, as seen in septic or ordinary biochemical infection, incisions should be made to permit of free drainage and escape of the poisonous products. Especially should this be the rule when the sting or bite has been made in tissues where loose cellular elements abound, as the orbit, around the anus, and external genitals.

Bites from the spider species are oftentimes of serious consequence and require the same treatment indicated above.

Serpent Bites.—Rattlesnake, moccasin, copperhead, and viper bites are often followed by grave symptoms, and sometimes by death. In India snake-bites cause thousands of deaths every year. The rattlesnake is responsible for most of the deaths from serpent bites in the United States. Poisonous serpent venom seems to be composed of two elements, one a direct depressant or paralyzer of the cardiac and respiratory centers, the other a disorganizer of the blood. The blood becomes thin, loses its power of coagulation, and exudes from small blood-vessels. Wide extravasation may occur. The red corpuscles disintegrate.

The first effect of the poisonous bite is pain, rapid swelling, and a black-green or purple discoloration of the skin in the immediate neighborhood of the bite. These local symptoms develop within an hour, even within a few minutes. As the local symptoms make their appearance, sometimes before, constitutional signs are manifested. Nausea and vomiting are apt to be early symptoms and may follow as rapidly after the bite as vomiting from a hypodermic emetic dose of apomorphia. The heart-beat becomes rapid and feeble, the respiration labored, and the skin clammy. Should the poisoning end in early death, according to

Weir Mitchell (Carmalt), "local extravasation may be all that is visible, but if it be postponed for a short time, then smaller extravasations are found in distant tissues. Most frequent and most pronounced are subpleural, subperitoneal, and subpericardial ecchymoses, but the whole organism is deeply affected, the tissues being congested and presenting a much darker appearance than normal. The blood does not seem to coagulate readily within cavities or interstices of the body, unless death follows almost instantly. In cases which live longer the blood remains constantly in the liquid state or coagulates imperfectly, and then only after being exposed to the air, resembling in this particular the state of that fluid observed in conditions of asphyxia."

The greater the proportion of the peptone part of the venom, that having a paralyzing effect upon the nerve centers, the quicker the death and less the disorganization and extravasation of the blood. Wide local extravasation commencing at the point of inoculation proves the excess of the globulin or blood-disorganizing element in the venom. Small doses of the poison produce comparatively mild constitutional and local symptoms.

Anomalous cases have been reported of the late appearance of both local and constitutional signs of poisoning after bites by venomous serpents, but these must be extremely uncommon.

Cases of severity which recover or which live from a considerable number of hours to as many days present quite characteristic symptoms. Prostration is marked, but the mind will remain clear, except in those fatal cases which end in coma. The swelling due to the disorganized, blackened, incoagulable extravasated blood soon spreads from the wound and its immediate neighborhood towards the trunk. In a case which the writer saw and operated upon successfully not only were the hand, forearm, and arm tensely swollen, but the shoulder, pectoral, and scapular regions as well. The violet-black, tense skin seemed upon the point of bursting. Should the pa-

tient survive the immediate constitutional effects of the venom, symptoms of infection, similar both locally and constitutionally to those of diffuse cellular inflammation, will probably follow. Areas of sloughing, gangrene, most often commencing in the neighborhood of the bite, are indicative of the passing of the venom poisoning into a more or less diffused cellulocutaneous inflammation. The condition is a result of the retention within the tissues of the extravasated disorganized blood.

Treatment.—The best way to treat rattlesnake bites is to educate the people likely to be exposed to such injury. Sportsmen and those whose occupation calls them to lead an out-of-door country life should be informed through sources of general information, most likely to reach their eyes, how best to take care of themselves should they be bitten by a venomous reptile. Although it is said that “a little knowledge is a dangerous thing,” yet in the case of the snake-bitten victim the knowledge of how to lessen the jeopardy to his life would be quite as valuable to him as the uses of the “First Aid” package to the wounded soldier and his comrades in the absence of the immediate services of a surgeon. It should be made known that a handkerchief, piece of a shirt, rope, or any available material should be thrown around the bitten limb, above the bite, and made as tight as possible. This is best done by tying the ends of the binding material together and then, after passing a stick (something else will answer the purpose) under the knot, twist the stick until the ligature constricts the limb so as to almost completely shut off the circulation below. The wound should be sucked, there being no danger in this procedure unless there be fresh wounds upon the lips or in the mouth. It might be the part of wisdom for the sufferer himself or a companion to make a free cut with a pocket knife into the skin at the site of the snake-bite. This would facilitate the escape of any poison left in the wound after sucking it. Any danger from sepsis caused by the pocket knife ought not to be considered, and as to the dan-

ger of cutting important parts this would be of little moment; the probabilities are that the cut would be made too small and too shallow, yet much good might be done. Whiskey and coffee are the only stimulants usually within reach, and these should be given freely. If a physician's services cannot be secured for many hours at the shortest, it would be proper and perhaps necessary for the sufferer, if able, or his companion, to loosen the ligature a little from time to time so as not to cause gangrene in the parts below. Great swelling of the limb, especially if the skin is of a dark "black and blue" color, ought to be relieved by punctures with the point of a knife. The kind of people apt to be bitten by serpents are not situated where the services of a physician are readily available, and neither they nor their friends will hesitate to do as just advised if they understand the reasonableness of the practice.

Little more than just recommended can be carried out by the victim of a snake-bite or by his friends, except to seek the services of a physician as early as possible. In addition to the scientific surgical technique of the practice just outlined as what should be common lay knowledge, the physician should place his reliance upon the hypodermic use of large doses of strychnine, repeated at short intervals. This drug should be given so as to produce its physiological effects within the limits of safety. Nitroglycerine may be used, but only in the very early periods, because of its tendency to increase the blood extravasations. Digitalis is too slow in its effects. Diffusible stimulants are required to overcome the cardiac and respiratory weakness. The injection into the tissues around the wound of a 1 per cent. solution of permanganate of potash has proven serviceable at the hands of some of my professional friends who practice in a section where snake-bites have to be treated. A chromic acid solution in water one-half of 1 per cent. has been recommended by those who have tried it.

For the swelling of the limb multiple incisions must

be made, and when life has been spared some days, and the swelling is excessive, through and through drainage has to be established at as many places as indicated. This was done in a case in my own practice referred to in a preceding page. One of my friends has told me that in addition to punctures and incisions he has painted the entire swollen surface with tincture of iodine, and as a result the green-blackish blood oozed through the skin like profuse perspiration. This oozing happens in rare instances without any irritation of the skin, so it would be good practice to try and bring it about by the use of the iodine.

When a snake-bite involves parts other than the extremities, the treatment is limited to stimulation, suction (cupping) of the wound, incisions, and the subcutaneous injections of the solutions mentioned.

The after-treatment should be tonic; iron and quinine in the way of drugs; good milk and easily assimilable foods.

Animal Bites.—Lacerated and punctured wounds inflicted by the teeth of healthy animals are only dangerous because of the severity of the injury, and require the same treatment as wounds of a similar character inflicted by inanimate objects. The bite of a human being is quite different, however, because of the common presence of many kinds of germs within the mouth. One of the worst infected wounds of the hand seen by me was caused by the bite of a man. Such injuries require thorough prophylactic disinfection with pure carbolic acid and alcohol; probably it would be best in all cases to enlarge the wound.

The bite of a dog suspected even of "being mad" should be cauterized thoroughly with pure nitric acid. Recent experiments upon animals have proven that after inoculation with the germs of hydrophobia, if the wound of the experiment be thoroughly cauterized with nitric acid, 90 per cent. of the animals escape infection. In addition to this treatment I would recommend a visit to some institution for the scientific carrying out of Pasteur's treatment.

CHAPTER XIV.

SPECIFIC WOUND INFECTIONS—ERYSIPELAS.

Under the head of specific wound infections we classify those surgical wound diseases in which a wound is followed by certain more or less marked classical local and constitutional disturbances. For the production of these diseases there must be a wound or point of inoculation, which may be of slight moment, and be completely healed before constitutional symptoms develop; or unhealthy repair precedes and accompanies the appearance and course of the general systemic poisoning. The infection or poisoning is microbic or bio-chemical. The diseases under consideration are separate and distinct from those mentioned when treating of interferences with wound repair caused by the presence of germs.

ERYSIPELAS is a specific infectious disease due to the entrance into the lymphatics, small veins and capillaries of the *streptococcus erysipelatus*, first discovered by Fehleisen, who, in his work on the Etiology of Erysipelas, published in 1883, tells how he proved conclusively that erysipelas is due to the infective properties of the streptococcus named after him. From little pieces of skin removed from patients suffering with erysipelas he made cultures on peptonized gelatine. From these cultures he obtained a streptococcus with which, after culturing many times (thirty generations), he inoculated eight persons, seven of whom developed erysipelas. This is as conclusive proof that this particular germ is the cause of the disease under consideration as that any other known germ is the cause of a classified disease. The bacillus develops in the skin, subcutaneous cellular tissue, and sometimes in the mucous membrane. The growth of the cocci produces an inflammation which tends to spread rapidly, and as a result of the growth products or toxins are formed which produce constitutional symptoms sometimes of a violent type. Clinical evidence has absolutely proven

the contagiousness of erysipelas and the mode of entrance of the contagium is always through some breach of surface. Although in the laboratory the identity of the erysipelas streptococcus with that of the streptococcus of suppuration is apparently established, yet clinically, erysipelas is followed by erysipelas unless the greatest care is exercised by the surgeon in passing from the dressing of a wound infected with erysipelas to that of a healthy wound. Whereas no such danger is encountered in the treating of several wounds, one after another, when one or more are the subject of suppuration caused by an infection of the streptococcus pyogenes. The greatest danger in this latter is that a healthy wound, free from suppuration, may become infected as the result of a shiftlessness of antiseptic details upon the part of the surgeon. The older writers, and even many of our modern ones, consume considerable space in describing how unhygienic conditions, the crowding together of many wounded, bad ventilation, poor sewerage, debilitated general health, *all* predispose to the development of erysipelas. This is only true in that such conditions lead to a laxity of enforcement of now well known and proven precautionary measures essential to keep out the invasion of many preventable diseases; all of which has been well illustrated by the lack of forethought and executive ability displayed by those in authority, and having in keeping the lives of soldiers in many mobilizations, and in the camps of those engaged in active field service. This has been as well illustrated at the close of the century in our late war with Spain, both in the camps at home and in the field in Cuba, as in the campaigns of Napoleon in the early part of the century, and in the Crimea in the middle part of the century. Although science has advanced and the cause and prevention of many diseases has become well understood during the nineteenth century, and particularly during the last twenty-five years, yet little improvement has been made in subverting human selfishness among politicians, military and civic, to the common cause of humanity.

Symptoms.—The disease is usually sudden in onset, there being an elevation of temperature to 101° F. to 105° F., with chills or even a rigor. There may be nausea and vomiting as observed in other acute diseases. At the end of about twenty-four hours a bright red rash makes its appearance around about and spreading away from a wound which may be apparently healed, insignificant in character, or of considerable size and importance. Most commonly the wound is, as has been described, "unhealthy" and not doing well. The rash is characteristic, disappearing momentarily on pressure and having a sharp and easily defined border. It does not gradually fade away from a center of great intensity of color to a pale border. Pressure is painful and there is intense burning over the area of the rash. The infectiveness of the disease is well shown by the enlargement of the lymphatic gland nearest the inoculated wound and the tendency of the infection to spread along the lymphatic channels to the next neighboring glands. Occasionally the rash is very pale, especially in anemic patients; more commonly the color is dark or cyanotic. The tenser the tissue the paler the rash and less the swelling. On the other hand, in loose tissues the rash is distinct in color and the swelling is very marked, and it is most often in loose cellular tissue that occasional complication develops, i. e., suppuration. Vesicles and bullæ are common, forming as the result of intense edema. These bullæ usually dry up, and, in fact, except in very much debilitated subjects, suppuration or a more general breaking down of tissues and the development of gangrene is rare. The rash varies in its duration from a few days to several weeks, usually one week to ten days. Relapse is common. There is a continuous elevation of temperature, which, however, is of little importance unless it reaches above 104° F.

After a few days the type of fever changes from that of a sthenic form to one denoting debility. Delirium is common and most often observed in erysipelas of the scalp and face. As the rash subsides, desquamation follows. Complications are sometimes observed. In

facial erysipelas the rash may spread and involve the mucous membrane of the air passages, necessitating operative measures to prevent death by suffocation. Secondary involvement of tissues other than the skin is brought about by an invasion of such tissues from an attack of the skin covering them. As for example, interior of joints, the peritoneum, the pleura and the meninges of the brain. However, this is not always so, as the writer has seen examples of secondary involvement of the pleura, brain, and peritoneum in cases where the disease began in the extremities. Probably all such cases are examples of blood poisoning, the germs being carried and lodged through the circulation into distant tissues and organs, setting up a secondary inflammation.

PHLEGMONOUS ERYSIPELAS is a serious and oftentimes dangerous form of disease resulting from the invasion of the subcutaneous cellular tissues, and intermuscular septa by the streptococcus erysipelatus. This inflammation results in more or less sloughing of the skin and subcellular tissues. The clinical picture of this disease varies little from that of the cellulocutaneous inflammations caused by a penning up of the products of suppuration in infected wounds, as described in former pages when writing of the necessity of drainage in deep seated suppuration. The inflammation usually begins in a wound of an extremity. There is rapid swelling, with discoloration of the skin, which suffers secondarily, the inflammation starting beneath and spreading toward the surface. The color of the skin is that of a deep red, which gradually fades into the healthy skin instead of the abrupt border of cutaneous erysipelas. The swelling soon becomes tense, brawny, and painful, and, as in the cutaneous varieties, bullæ often form and, unless relief is given by the surgeon, local areas of gangrene develop at the points of greatest tension. The forerunners of such a condition are observed as areas of dark blue color of the skin with edema and doughiness; sometimes an indistinct fluctuation is present. Through the openings afforded by the at first circumscribed

areas of gangrene rather a profuse discharge of pus takes place. In cases where there has been great tension, with late relief either by the surgeon or unaided nature, extensive sloughs of the skin form. These may expose the muscles, the enveloping membranes of joints, and in cases where the original injury opened up intermuscular planes, extensive destruction of muscles and even bone results. It is especially in the latter condition, as, for instance, where erysipelas complicates a deep seated wound, that the rather slow formation of sloughs and escape of pent up pus results in blood poisoning. In such a case the pus, instead of seeking the subcutaneous cellular tissue early, often seems to elect first traveling between muscles and close to bones.

The constitutional symptoms are marked by pain, fever, early depression, especially if there is profuse suppuration and sloughing. Unless there is early relief of pent up products of the inflammation, blood poisoning with or without secondary infections and suppuration in distant organs or tissues is apt to follow.

Treatment.—Every case of erysipelas developing or brought into a hospital should be isolated and every known principle of antiseptic surgery carried out in the treatment of the case. In examining and dressing the wounds sterilized rubber gloves should be worn and the naked hand should under no circumstances come in contact with the wound, body, or bedding of the patient. If this precaution is adhered to the danger of infecting others will be lessened. It will not do to rely upon wearing sterile rubber gloves at operations, and at other times (after handling a case of erysipelas), in the office, private residence, or dispensary, when doing little things, use the naked hands. True it is that the hands can be sterilized so that they will be ordinarily safe, but it is also true that the germ of erysipelas is very poisonous and hard to wash away. The writer recalls very vividly a personal experience in which he carried erysipelas from a case of erysipelas of the scalp, following a minor operation in private

practice, to four other individuals, one in hospital, three in their homes. Every precaution seemed to have been taken, and exactly where the leak occurred is not known to this day, but there was a leak, and although no fatality resulted, much needless suffering did.

Precautions against infecting others should be taken by nurses as well as doctors. It is best always to have a special nurse for such cases. In spite of a prejudice against it, there is no more grateful or curative agent in the treatment of cutaneous erysipelas than moist cold. Cloths wrung out of a cold, mildly antiseptic solution are best for application, and the wound of inoculation should be treated upon its merits after the rules laid down for the treatment of infected wounds,—drainage with antiseptics.

Numerous cures for cutaneous erysipelas have been offered, and some are beneficial. Among them the covering of the inflamed area by an ointment of ichthyol in lanoline, one dram to one ounce. A solution of thiol in water, 20 to 40 per cent., is recommended. This is painted over the infected skin as well as for some distance beyond. Thiol is less objectionable than ichthyol because of the bad smell of the latter, and it is reported to be almost a specific. Abortive measures by scarifications and the use of strong antiseptics are valueless to abort; at least that is the personal experience of the writer. The lead and opium wash is a soothing application, and is useful and grateful to the patient when the wound is insignificant. Shallow or deep incisions ought to be made when there is tension sufficient to threaten the life of any area of skin. Tonics, and especially strychnine and the muriated tincture of iron, are of value.

Cellulo-cutaneous erysipelas demands surgical interference. An incision or incisions to the bottom of the wound of infection must be made, and early. Sloughing of the skin should be anticipated by incisions before the vitality of the tissues is more than threatened. Free drainage should be established and maintained by copious and frequent antiseptic irriga-

tions, and the part should be enveloped in large, moist antiseptic dressings. Tonics, stimulants, and forced feeding are essential to maintain strength and resisting powers. Cold applications are harmful in this form, as tending to increase the danger of sloughing.

Secondary complications may require incision at a distance,—they should be made early. Usually careful dressings, skin grafting, or transplantation of large flaps will suffice for the repair of spaces of raw surfaces uncovered by sloughing. Occasionally, but rarely, amputation is required. It should never be done during an acute stage of infection. Death rarely follows acute cutaneous erysipelas, the mortality being less than 5 per cent., except among old people and children, when it is larger. The phlegmonous variety should be rarely fatal when treated properly. There will be, however, occasional deaths in spite of our best directed efforts.

CHAPTER XV.

TETANUS.

This is a disease due to a specific wound infection, and is characterized by painful tonic contractions of muscles of voluntary motion, beginning with those of the jaw or neck, and spreading to the muscles of the trunk and extremities. The germ causing tetanus was first discovered in 1884 by Nicolaier, but it was not until 1889 that bacteriologists succeeded in making pure cultures. To Kitasato, the distinguished Japanese scientist, belongs this honor.

In order to comprehend more fully the essential factors in the causation, clinical history, and treatment of tetanus it may be well to refer somewhat to the results of bacteriological studies of the tetanus bacillus. The bacilli are slender and straight, of slight motility, and present on one end an enlarged or pin-headed extremity. This enlarged end is the spore or offspring of the bacillus. The germ is anaerobic in character, i. e., cannot live in the presence of oxygen; grows best at the temperature of the body, having slower developing powers at lower temperatures, and below 56° F. ceases to grow. Dried spores live indefinitely, but are killed in a few minutes if exposed to moist heat at the temperature of boiling water. "They withstand in the moist condition, for an hour, a temperature of 80° C., a property which was utilized by Kitasato to destroy other bacteria in obtaining pure cultures of the tetanus bacillus. The spores survive and preserve their virulence for ten hours in 5 per cent. carbolic acid; they are killed in fifteen hours. They are not killed by putrefactive bacteria."—(Welch.)

It is instructive to note that in experimental tetanus the period of incubation after inoculation of an animal varies from a few hours to as many days, and although this is also true of man, yet infrequently

many days or even weeks elapse before the symptoms of tetanus develop after infection. The rapidity of the development of tetanic symptoms after infection must depend upon the dose and the miscibility of the tissues at the point or surface of inoculation with the bacilli so as to produce the toxins or ptomaines whose action upon the spinal cord produce the peculiar muscular spasms.

Notwithstanding the tetanus bacillus is widely distributed, more especially in warm climates, having been discovered in almost all kinds of outdoor dirt, manured ground, etc., yet because of the anaerobic character of the germs, their growth in wounds is mostly confined to those in which they are carried deeply into the tissues at the time of the production of the wound.

Before the cause of tetanus was discovered the clinical history of the disease, and possibly the treatment, was as well taught as to-day, but because of ignorance as to the causative factor many fancied theories were advanced in this disease, as in most others, relative to rather mysterious nervous influences, climatic changes, etc., being responsible for its production.

Tetanus may follow injuries and wounds of one part of the body as well as another, although the feet and hands, and especially the former, are most often subjects of punctured wounds likely to be infected by the tetanus bacillus,—punctured and lacerated wounds leaving foreign bodies, and those likely of contamination with street dirt, garden dirt, and manure; for example, splinters from boards on old fences or those lying around on the ground; old rusty nails, parts of 4th of July explosives “set off” in public streets or in the house yard. Every year a large number of cases of tetanus are reported following little wounds from parts of the caps of toy pistols. In these last cases, probably the germs were on the hands, and were carried into the tissues along with the pieces of pistol caps.

Tetanus has been known to follow all kinds of

operation wounds, but this was prior to the modern comprehension of antiseptic and aseptic surgery. Of course, in emergency surgery it might be impossible to prevent infection by the tetanus bacillus, but in operations of election there could be no excuse. As in erysipelas, the wound of entrance of the infection may be so insignificant that some cases have been called idiopathic, but, with our present knowledge, we must insist that *no wound, no tetanus*. In this connection it may be proper to refer to the case of a bull dead of tetanus of whose flesh several persons ate; three were seized with tetanus and two died. This observation was made many years ago, 1857, by Betoli. Tetanus is found in the new born infant, infection occurring through the cord, also in the puerperal woman, or after abortions. These differ in no way from the common varieties of tetanus.

Clinical History.—Tetanus is either acute or chronic. The acute form is ushered in from a few hours to three weeks after infection. Most commonly two or three days elapse between the time of infection until the first symptoms develop. Then the patient notices a difficulty in opening the mouth, with more or less cramping in the muscles of mastication. The neck may be a little stiff and the patient attribute the whole difficulty, which in the beginning is usually mild, to "taking cold." In some hours the symptoms become aggravated and the cramping of the muscles of mastication becomes so severe that the patient cannot open the jaw, or can at best only slightly separate the teeth (lock-jaw). The muscular contractions are painful, usually excruciatingly so, and fluids are swallowed with great difficulty. The muscles of the face and back of the neck soon become involved, causing a peculiar expression called *risus sardonicus*. Sometimes before the face muscles are involved, those of the trunk and extremities exhibit spasmodic contractions with cramping *pains*. As in experimentally produced tetanus in animals, the muscles of the parts nearest the point of inoculation are first affected, so in man the first muscular spasms may appear near the

wound. The muscular contractions soon become almost continuous; swallowing is painful and difficult, and often brings on fresh muscular spasms, in fact any stimulus, as a sudden noise, cold draft, or any irritant or voluntary effort, may do this. The back muscles may contract so as to produce opisthotonus. Lateral and forward contortions are sometimes observed. Except during unusual muscular contractions, the patient lies on his side with the head drawn back and the spinal arch exaggerated. There is perfect consciousness. There is retention of urine and the bowels refuse to act because of the contraction of the sphincters. The urine is albuminous. Most commonly there is fever from the beginning which may be quite high. More rarely there is no fever, but usually the fever of itself is not alarming.

Diaphoresis is almost always a feature of the disease and occurs always after severe convulsions. There is little sleep without drugs. Attempts at swallowing may bring on a renewal of convulsions; the face may become cyanotic because of the spasm preventing respiration or causing a closure of the glottis. In the intervals of spasms, the face is anxious and pale. Death is generally the result of exhaustion or spasm of the muscles allowing of respiration. Very high temperatures are common a short time before and after death; a fatal termination occurs most often before the end of the fifth day and can occur within twenty-four hours. In the chronic form the symptoms occur later, after infection, and are milder in character. There is little or no fever. The onset of the symptoms follows in the second or third week after the injury. The clinical picture is quite similar to that of acute tetanus, only not so impressive. There are remissions and even intermissions of all symptoms. Gradual improvement takes place and the patient recovers. Death may take place.

Head Tetanus.—A very dangerous though rare form of tetanus follows infection of areas supplied by the cranial nerves, especially in the neighborhood of

supraorbital branches. There is paralysis of the facial nerve with trismus, and at times great difficulty in swallowing. A maniacal frenzy is sometimes observed. There may be more or less general tonic muscular spasms.

Diagnosis.—There should be little difficulty in making a diagnosis of tetanus. It has to be differentiated from inflammatory difficulties about the mouth or temporo-maxillary joint. These can be detected by inspection and palpation, and in case of the joint being affected, this is most commonly unilateral. In tetanus there is an early rigidity of the muscles of the neck. In severe strychnine poisoning there are usually complete periods of intermission (found also in chronic tetanus). The muscles of the hands are rarely involved in tetanus, in strychnine poisoning they commonly are. The spasms of hydrophobia are clonic.

The prognosis is bad in acute tetanus, but the favorable signs are late onset, long duration, lengthening of intervals between attacks of muscular cramps. Statistics seem to prove that an attack coming on under ten days after infection only 4 per cent. recover; after ten to fifteen days, 27 per cent.; after fifteen to twenty days, 45 per cent.—(Rose.)

Treatment.—Careful antisepsis is of the greatest importance as a prophylactic measure, and besides all punctured and other kinds of wounds likely to have carried the germs of tetanus into the tissues should be freely opened, all foreign bodies removed; cleansed by, first, using peroxide of hydrogen or pyrozone, because of the anaerobic character of the bacillus; then thoroughly antiseptized with pure carbolic acid; wash this away with 95 per cent. alcohol. Tincture of iodine or a saturated solution of permanganate of potash may be employed. All such wounds should be treated on the open, free drainage, antiseptic plan. After the development of the symptoms, the same antiseptic plan of treatment should be followed as far as practicable. All irritation should be avoided and absolute quiet enforced; liquid food may be swallowed, or failing in this, a tube may be introduced

through the nose and suitable nourishment poured through it into the stomach. Sedatives, such as chloral, bring some relief to the patient, but it is doubtful whether or no a patient was ever saved by drugs. When these drugs are used they should be given so as to produce their physiological effects and control the convulsions. No stated doses can be given. The giving of sedative drugs is recommended chiefly as a humanitarian practice. Chloroform is useful to control spasms.

The belief of the writer is that in the working out of the antitoxin treatment of tetanus lies our only hope of a cure. In experimental medicine much has been learned and accomplished, but practically in the treatment of the human sufferer from tetanus little has been accomplished.

The serum to date is simply an immunizing agent and not an antitoxin or agent capable of counteracting the effects of toxins already in the blood. Immunizing injections should be given in suspicious wounds, and in the beginning of tetanus the antitoxin as made should be tried with the hope of its modifying the symptoms.

CHAPTER XVI.

TREATMENT OF SEPTIC BLOOD POISONING.

By septic infection we mean a general disease caused by the entrance into the circulation of the germs of suppuration or the products of these germs. The germs gain entrance at the point of inoculation either through an external wound, or being present in the circulation are enabled to act deleteriously because of some local depression or want of resistance upon the part of the tissues.

The clinical picture varies in accordance with the kind of infection or blood poisoning. When the action of certain germs results in the rapid production of a toxin or poison the absorption of which causes a depression to the vital centers, followed by a greater or less interference with the natural functions of the emunctories, a most serious condition is brought about. The outcome will depend upon the quality of the toxin (commonly called a chemical substance or ptomaine), and the amount of the poison absorbed.

The Unusual Form of Septicemia—Sapremia.—Fortunately this form of blood poisoning is rare and its source not difficult to recognize, being more commonly the result of the decomposition of clots in the uterus after abortion or full term pregnancy. It is found as the result of decomposition of clots in wounds, rarely those of a subcutaneous kind. The infection is characterized by a rapid rise of temperature, 103° F., to 105° F. There may or may not be a chill. The temperature continues high and symptoms of vital depression develop. The skin becomes clammy, the tongue dry, the pulse rapid, the second heart sound indistinct.

Diarrhea may develop. The patient dies in from two to five days. This is the picture seen when the expectant plan of treatment is practiced. Quite another picture is presented if rational surgical principles are early adopted.

Treatment consists in the removal of all decomposing materials and the use of copious irrigations, with the maintenance of good drainage. Recovery is prompt, provided the source of the toxins is recognizable, and can be reached before there is great vital depression. It is to be remembered that although the surface temperature may not be high, possibly sub-normal, because of the condition of the skin, the rectal temperature will always be found at least several degrees above normal. Many times after abdominal operations this rapidly fatal form of blood poisoning has developed, the condition being attributed to shock, when had the rectal temperature been taken so soon as bad symptoms appeared, possibly lives might have been saved by an attempt to remove the cause of infection.

Even though the focus from which the intoxicant started may be reached, usually little good will result. So large a surface for the absorption of toxins is presented within the abdomen that the prairie fire like speed with which the poison spreads admits of such an overwhelming dose of the toxins being absorbed, that vital centers are paralyzed and death is almost inevitable. The spread of the infection over the peritoneal surface may be so rapid that few naked eye changes are observable in that membrane.

The treatment is preventative, and may be stated by formulating one or two good rules. After a celiotomy try never to leave within the abdomen any fluid or clotted blood. In most cases this can be done by a careful hemostasis and the sponging away of all blood from the peritoneum without or after irrigation.

Many times raw surfaces can be covered by peritoneal flaps, and stitches introduced at well selected sites will shut off exposed areas and at the same time minimize oozing. Often, however, it is impossible to prevent some oozing and at times rather free bleeding from raw, torn surfaces. In such cases drainage must be established and maintained until the oozing becomes serous.

If the bleeding is free, the drainage is combined with pressure by using gauze packing. The Mikulicz, iodoform gauze drain is the best for this purpose, because a piece of gauze cannot be left behind after what was supposedly a complete removal of *all* gauze. Besides the pressure upon and drainage of the parts involved can be gradually reduced, and in the carrying out of this there is less local disturbance and pain than when separate pieces of gauze are removed, each of which is in direct contact with the peritoneal surfaces.

A word about iodoform. It has a property that no other material is known to possess, and is of great value in the preventive treatment of *all* forms of blood poisoning. It takes only a few hours after the application of iodoform to a fresh wound surface for the formation of a deep zone of leucocytes and connective tissue corpuscles held within the meshes of fibrinous trabeculæ—an exaggerated fibrino plastic exudate. This rapidly formed exudate represents the developmental stage of a protective granulation tissue formation.

Suppose an abscess deeply situated and partly inaccessible containing highly infective pus, and so situated that it is impossible after incision to immediately thoroughly remove, disinfect, and change the character of its secreting surfaces. The protective property of iodoform when applied to a cut surface in such a case is undeniable. Likewise in the incisions for the evacuation of tuberculous abscesses whose sources and channels of descent cannot be *thoroughly* curetted, and therefore should not be curetted at all, iodoform forms a safeguard against a mixed infection of the tuberculous lesion from without, as well as a protection against a tuberculous spread to the tissues involved in the wound.

The property iodoform has of causing the rapid formation of a protecting fibrino plastic exudate is likewise of great value when iodoform gauze is used as a packing and drainage material in intra-abdominal work. Should infective germs gain entrance from

without along the iodoform gauze drain, and this occasionally happens as the result of carelessness or *in spite* of great care, any infection of the peritoneum would be merely a local affair, i. e., one with the formation and discharge of pus without manifest dangerous constitutional symptoms.

Pyemia.—In several preceding chapters the treatment of wound infections, *septicemias*, as met with under a numerous variety of conditions, has been discussed within the limits intended in these pages. There is one particularly important form of blood poisoning which requires more elaboration and is called *pyemia*. It has been defined and recognized by modern surgeons as a “general infective disease which arises from the entrance into the blood of the constituents of infected pus. It is distinguished from other septic infective diseases by the development of multiple abscesses in various organs and by an intermittent fever.” Of course from the earliest times it was recognized that, in inflammatory conditions characterized by the formation of pus, in some cases multiple abscesses formed and that the type of the disease was a dangerous one. The pus was said to be “in the blood.”

When pus germs, or infected thrombi, originating in a wound, or from an inflammatory lesion within the body, enter the circulation certain symptoms result. These vary in character and intensity and depend upon the localities at which the elements are arrested. The amount and frequency of detachment and entrance into the circulation, either from an original focus or from a metastasis, determines the nature and seriousness of secondary infective processes. Although it is usual for the starting point from which a pyemia develops to be an infected suppurating wound of a longer or shorter duration, sometimes this focus is quite insignificant as has been observed when discussing poisoned wounds.

Symptoms.—The disease is almost always ushered in by either a violent chill, or chilly sensations and chattering of the teeth. The chill may last only a few

minutes, an hour, or possibly longer. The temperature rises several degrees, in many cases as high as 105° F. In from eight to twenty-four hours the fever disappears; the temperature may then be subnormal. There is marked depression. The chills recur, sometimes several in a day. With each recurrence the general depression increases, the skin takes on a leaden hue, the features become pinched. There often is an increasing irregularity as to the time of the chill. High fever is frequently followed by a marked remission or a subnormal temperature.

The usual accompaniments or results of fever due to blood poisoning are observed, viz.: Thirst, loss of appetite, emaciation. During the rise of temperature there may be only a little mental disturbance. In some cases, however, the nocturnal delirium is marked. The type of the fever simulates in most cases an intermittent malaria, in others it may be not unlike a pernicious malaria. The irregular chills are probably the result of the intermittent entrance of pus into the circulation. Not long after the irregularity of the chills is well established, clinical evidence of inflammation of joints, bones, muscles; or internal organs, as lungs, liver, spleen, and brain, will be detected, and if the patient lives long enough abscesses will develop in one or more of these parts.

The parotid gland is not infrequently attacked, and the writer has observed this most often as an accompaniment to a suppurative inflammation within the abdomen. With the development of the chills the wound takes on an unhealthy condition, the granulations become pale, the discharge thin and scanty: the parts around about swell, the skin is pale and brawny. All repair ceases. The prognosis is grave, but not hopeless, and depends upon the employment of early rational treatment.

Treatment.—Possibly the writer can best illustrate the subject by referring to one or two cases which have been of value as object lessons to him. A cowboy was wounded by the accidental discharge of a 44 cal. Colt's revolver, carried in its holster at his

right hip. The bullet entered the right leg at a point a little below and midway between the head of the fibula and the tibia, and passed directly downwards through the muscles on the anterior tibio-fibular region, crossed the ankle joint in front of the external malleolus, and lodged under the skin on the outer side of the foot near the base of the fifth metatarsal bone. The man had been brought to the hospital in a wagon, a distance of fifty miles, and arrived about twelve hours after the injury, the wound having received practically no attention.

The parts were cleansed, the bullet extracted, and an antiseptic dressing applied. Although suppuration developed, everything went along fairly well until the sixth day. At this time the man had a severe chill followed by a high fever. The next day there was another chill. The wound stopped secreting, the leg began to swell. The chills recurred, the temperature reaching sometimes as high as 105° F. On several occasions there was a subnormal temperature following a marked elevation. Delirium, especially at night, was almost constant. An interesting phase of the delirium was the patient's desire for the possession of his gun in order that he might "fix" me. He had been a bad man in Texas. This was illustrative of the usual querulousness which accompanies the delirium of pyemia. The swelling extended from the leg to the thigh. The scrotum swelled. The skin of the leg and thigh was pale and glistening, the superficial veins were prominent. The pulse became fast and feeble. He commenced to cough and the physical signs of fluid in the pleural cavity were made out.

A fluctuating swelling formed in the left axilla. The breath had a characteristic, sweet, fresh hay odor. On the thirteenth day after the injury the man died. A post-mortem examination showed that pus had traveled through the torn muscles up and down the leg between the bones. The veins were partly obstructed by clots. There was pus in the left pleural cavity, as well as in the axillary swelling. Being a subordinate, my duties had consisted in the extrac-

tion of the bullet and the making of the post-mortem examination, but I observed the treatment. It had consisted in attempts, usually unsuccessful, to wash out the long track of the bullet with an antiseptic solution; the introduction of drains into both wounds, and the local application to the leg and thigh of most of the remedies for cellulito-cutaneous inflammation, recommended in Naphey's "Surgical Therapeutics." Quinine, iron, and whiskey had been given in full doses.

Within a week after this man's death it so happened that an exactly similar case came under my care. During a few moments of hilarity between dances at a frontier party, a drunken cowboy amused himself by shooting alternately into the ceiling and floor. The last shot struck the floor, but not until after the bullet, a 44 cal. Colt's, had followed exactly the same track as in the preceding case. The man was put into a wagon and brought to the hospital, a distance of forty-five miles. After scrubbing the leg and foot they were bathed in a 1 to 1,000 solution of bichloride (this drug as an antiseptic had just been introduced into surgical practice). Fearing infection, a Gouley urethral dilator was passed into the wound as a guide and a free incision made in the long axis of the bullet track about its middle third. Drainage tubes were introduced and an antiseptic dressing applied. Irrigations were used daily and the wound repaired with little suppuration in a short while.

As an illustration of chronic pyemia, rather infrequently met with, the following case recently seen will serve as an example: A young man 30 years of age was attacked in August, 1898, with a right-sided pleuro-pneumonia. This ended in a sacculated empyema of the lower part of the pleural cavity. For weeks the pus was allowed to stay undisturbed. Nature finally tried to bring about relief and the abscess ruptured into a bronchus. A large quantity of putrid pus was coughed up. Following this there was improvement. For several weeks the continued fever, sweating, and loss of appetite were much modified.

Then the raising of pus ceased and at the same time the constitutional symptoms became worse. Uphill drainage would not suffice; the opening in the bronchus closed. The patient's general condition became much run down. The opening into the bronchus closed and reopened several times, the patient losing ground continuously. Numerous superficial abscesses formed. The skin on the extremities exfoliated in several places, especially on the hands and feet, leaving raw, bleeding surfaces. The temperature varied daily from normal, sometimes sub-normal, to two or four degrees above normal. The tongue was usually dry, appetite poor; bowels sometimes quite loose. Emaciation had become extreme. There were several bad bed sores. The mind wandered; exhaustion was extreme. The pulse was rapid and feeble.

The appearance of this individual when seen by me in December, 1898, was pitiable. At this time there was no drainage. It was suggested that a dependent opening be made by means of a trocar; slipping a drainage tube through the canula so that drainage might be established without shock. The procedure was not urged as the case seemed hopeless, death being apparently only a day or so off. It has been learned that nothing was done, yet the patient lived about three weeks longer.

Treatment.—Pyemia ought never to develop from a wound which can be managed from its early history according to the principles of antiseptic surgery. Occasionally cases will be met with in which from the nature of the wound it may be impossible to prevent the development of suppuration. Likewise satisfactory drainage cannot always be had, yet the great majority of wounds, if seen sufficiently early, can be protected against infection. If infection is suspected or has already developed in a wound and remained local, the infected focus can be disinfected and drained so as to prevent systemic poisoning.

Cases I and II may be briefly discussed in illustration: In the former a probably infected wound was received for treatment. Had disinfection and drain-

age been carried out as in the latter it is presumable that the result would have been favorable. Immediately after the commencement of the symptoms of pyemia, the only rational course to pursue under similar circumstances would be to lay the track of the bullet open, going to the bottom of every discoverable pocket or recess.

Having done this the whole wound should be thoroughly disinfected by some strong antiseptic, preferably pure carbolic acid, 95 per cent., which is best washed away by alcohol, and then either a normal salt solution, or if preferred, a 1 to 2,000 solution of bichloride of mercury in water may be used for irrigation. The wound should be lightly packed with iodoform gauze and over this a moist antiseptic dressing applied. In many cases of beginning pyemia such a line of practice will localize the infection. In more complicated conditions, for example, in involvement of bones, the infection being of the nature of an acute osteomyelitis, sufficient openings in the bone should be made with chisels and trephine to admit of a free use of the Volkmann sharp spoon, followed by a similar disinfection, drainage and dressing. No case of infective (suppurative) cellulocutaneous inflammation, whatever its exciting cause, should be treated other than by the free use of the knife, and the maintenance of good drainage. Pus may not always be found but tension is relieved. Metastatic abscesses should be opened as soon as recognizable, and their cavities disinfected and drained. Of course secondary abscesses of the lungs, liver, kidneys, and spleen offer difficulties of recognition and treatment, yet there is no reason why they should not be attacked when the vitality of the patient admits.

Chronic pyemia requires the same surgical treatment as the more acute infections. Insufficient drainage of a pus cavity was the cause of death in Case III. The writer has seen a number of cases of empyema, which terminated unfortunately; not because of the acute virulence of the disease, but rather from a more or less prolonged intoxication, either septi-

cemic or pyemic. Nearly all of these cases will recover if drained early, and it is not a question of technique (rib resection or not), but one of free and sufficient drainage for the particular case. Uphill or any other incomplete drainage of a septic focus is not only unsatisfactory but dangerous.

If in any case of pyemia complicated by a septic phlebitis it is possible to discover at what point or points ligatures may be applied to the infected veins so as to prevent central poisoning from detached septic clots, such practice is logical. The difficulty is in being able to determine the limit of the clot formation towards the center of the circulation. Amputation may sometimes be justifiable when an attempt to save an extensively infected extremity would too greatly jeopardize life.

The medicinal treatment of all forms of septic blood poisoning is supportive. Iron, quinine, and strychnine should be given in liberal doses. Alcohol in the form of whiskey or brandy is thought by many to be of great value and to act as an antitoxin. Maybe it is, but alcohol is a depressor of the nervous centers, and except when administered for some short-lived, express purpose, as preliminary to a surgical operation for its courage stimulating, and anesthetic effects, had better be given with caution. Copious quantities of water internally and externally, are of unquestionable value in aiding the elimination of poisonous products. Every effort should be made to sustain the strength of these patients by the giving of as much easily digested food as possible. It is often advantageous to administer nourishment and water per rectum.

CHAPTER XVII.

COMPOUND FRACTURES OF LONG BONES.

In cases of compound fracture the fate of a limb and often a life depends upon the care with which the wound is handled from the time immediately following the accident until the dressings and splints are applied. Independent of the purely surgical treatment of the injury, great importance must be attached, in bad cases accompanied by severe shock, to the means employed in combating shock and preventing increased trauma and irritation in the transportation of the patient to his home or a hospital. Given a case of compound fracture sufficiently grave in character to produce dangerous depression, the first aim of the surgeon should be the administration of restoratives. Usually it is necessary to rip or cut the clothing in order to inspect the site of fracture. If hemorrhage is going on, this should be controlled by direct pressure applied by means of antiseptic gauze and a bandage. Failing these, any freshly washed and ironed material may be substituted. Spurting vessels may be secured by artery clamps, which, when the urgency admits, must be washed or dipped in some strong antiseptic. However, the surgeon should not stand on antiseptic ceremony, but *immediately* stop a free hemorrhage by direct digital pressure or the application of the pocket-case artery forceps. In serious injuries, accompanied by free hemorrhage, the immediate control of the bleeding is of the first importance. If the source of the hemorrhage is not to be reached by the ordinary first aid means just mentioned, an elastic or some improvised tourniquet should be applied to the limb above the injury at a point where the main artery can be compressed with the least constricting force. Attention is directed to this last matter, because it has been observed that in compound fractures resulting in a

devitalization of the parts below the injury, if any elastic tourniquet had been rather tightly applied and allowed to remain a considerable time before the devitalized part was removed by operation, that the flaps of the wound made by the surgeon sloughed. It should also be remembered that when pressure is made directly onto the wound, wide extravasation may follow; likewise if infective germs have already entered the wound prior to the surgeon seeing the case and the application of his compresses, these germs may be forced into the tissues by the extravasating blood current. A wound which might have been made safe by the employment of antiseptics would possibly in this way be rendered impossible of sterilization. Therefore, for this reason, and also when marked extravasation of blood is going on with little external hemorrhage, it is safe to presume that a large, deeply situated branch or a main vessel has been wounded. Under these circumstances a tourniquet should be used as just suggested. Except for the combating of shock and the control of excessive bleeding, the duty of the surgeon who sees the patient for the first time is to apply a temporary antiseptic dressing without any attempt upon his part to explore or handle the wound. The usual signs of fracture, together with the presence of a wound at or near the site of crepitus and increased mobility and change of axis, are sufficient for the diagnosis. Nothing can be gained at this time by an exploration, digital or instrumental, and much damage can be done, yet how common to learn of the officiousness of some doctors (usually hangers on) called upon to care for those seriously injured, when carried into the nearest drug-store. The writer has treated many cases which had been fingered and probed with and without attempts at antiseptics. This harmful and useless interference having been done at places and under circumstances that no profit could have been made of any knowledge gained. He is confident that much unnecessary suffering, and occasionally death, even in this our boasted era of surgery, results.

If a bone is protruding it is not wise to replace it until after the careful use of antiseptics, and as this can rarely be done before the patient is moved to his home or a hospital, the best practice is to apply the temporary dressing without interference. In this connection it may be well to take notice of the "First Aid," or Esmarch package, in use in our army and in the German army. It contains in a small compass the essentials of a primary occlusive antiseptic dressing; can be carried in the surgeon's bag or ambulance box without danger of contamination, and keeps almost indefinitely. The usual precautions recommended in transporting cases of simple fracture of the lower extremities to their place of permanent treatment must be painstakingly followed. When the fracture is of an upper extremity the sufferer can walk or ride sitting up, unless the nature of the fracture contraindicates, the wounded member being supported in a sling.

Before proceeding to the examination and treatment of the fracture everything should be gotten in readiness as we do for any surgical operation, and especially one where we know that a slip in antiseptic technique may be followed by most serious consequences. In hospitals everything is at hand, but in private practice this is exceptionally so in emergency surgery. If the surgeon has had time to secure a roll of sterilized instruments, so much the better; otherwise, he must either boil his instruments in some suitable vessel; perhaps he may have a sterilizer at hand, or they may be placed in a 1-20 solution of carbolic acid and allowed to remain in this while preparations are progressing; his other armamentarium is supposedly always ready for use. Plaster of Paris in bulk or bandage should be secured. The preparations detailed in a former chapter are arranged according to the circumstances and surroundings of the case. Two solutions, one of carbolic acid 1-20, and the other of bichloride of mercury 1-500, must be at hand; from these weaker solutions can be readily made. A piece of rubber sheeting or table oil-cloth of

sufficient size should be washed in soap and water, sponged off with alcohol, and then douched with a solution of bichloride of mercury 1-1,000. Everything being in readiness, the patient should be anesthetized. After the clothes are removed, he is placed upon the operating table, bed, or floor in such a position as to allow of the easiest manipulations upon the part of the surgeon and his assistants. The rubber sheet must be put under the injured part so as to drain away fluids into some bucket or pan, and also arranged to shut off the wound from contamination by contact with other parts of the body, bedding, etc. Of course the most painstaking care is exercised by everyone taking part to keep the hands surgically clean. The temporary dressing is removed, if one has been applied, and the wound protected by covering it with a sufficiently sized piece of moist antiseptic gauze. The greater part of the extremity above, around, and below the wound is now well scrubbed with soap and water, shaved, and then douched off with a 1-1,000 solution of bichloride of mercury. The area about the wound is now sponged with alcohol and then douched again with a 1-1,000 bichloride solution. Sterile towels, or "clean" towels after being wrung out of a 1-1,000 bichloride solution, are wrapped around the limb above and below the injury and spread about so as to prevent contamination. It is safer for the surgeon to wear rubber gloves previously sterilized and kept protected and ready for use. These gloves should be drawn over the hands after the latter have been properly washed, and not removed until the limb has been prepared for examination and operation. The gloves can then be pulled off either by an assistant using an antiseptic towel to prevent contamination of his own hands, or by some one whose duty cannot in any way bring his hands in contact with the surgeon's or assistant's hands, the wound, or any article of possible service in the operative technique. In hospital practice it is always safer and should be practicable for surgeon and assistants to wear sterile rubber gloves *in all operations*. Those taking part in

the preparations for an operation changing gloves, with antiseptic precautions, before taking part in the operative procedure itself. These refinements are not absolutely essential, but when practiced, are in touch with the technique of the most successful surgeons. One may well wonder, when casually viewing the hands of some general practitioners and surgeons as we meet them in consultation or socially—would it be possible for such hands to be so washed as to be surgically clean! For all such we urge the use of sterile rubber gloves.

TREATMENT.

We now come to the line of treatment to be followed, and this must depend upon what our examination discloses.

The Simple Cases.—In a large percentage of cases the wound through the soft parts is of itself not of great moment, neither is the injury to the bone; the danger to be feared is infection. In order to reduce this danger to a minimum the following practice has given the greatest success: When the bone is protruding it should be thoroughly disinfected with a strong antiseptic. If apparently clean after irrigation, it should be sponged over carefully with a 1-500 solution of bichloride and then irrigated with a weaker solution. Any dirt, coal dust, or grease which may have gotten onto and apparently almost into the broken bone should be removed mechanically with forceps and gauze saturated in alcohol. The bichloride sponging (1-500 solution), and later irrigation with a much weaker solution (1-2,000 or even 1-4,000), will make the protruding bone end free from active pathogenic germs. If the skin wound is too small to allow of thoroughly digital exploration, a suitable incision is made and the injury examined by the finger, any loose detached fragments of bone, foreign bodies, and dirt are removed, and if the examination discloses a limited soft part injury the operation is completed by irrigating the wound throughout with a 1-1,000 bichloride solution, and then reducing the pro-

truding end. After this reduction another irrigation with a 1-4,000 bichloride solution is advisable. One or more rubber drains are introduced, a moist antiseptic dressing applied, and the limb immobilized. For the purpose of immobilization no material answers quite so well as plaster of Paris. A cast may be made to surround the limb, possibly cutting a window over the wound area for the dressing and inspection of the injury. The writer prefers to apply plaster splints, one or more, so as to allow of easy inspection and dressing of the fracture; the whole affair admitting of removal and reapplication.

Plaster of Paris Splints. — Having determined whether one or more splints are required to support the limb without covering the wound, and perhaps in some cases this may not be objectionable, suitably sized pieces of heavy muslin or Canton flannel are cut of a length, and when folded three times, of a breadth corresponding to the proportions of the proposed splint or splints. Having spread the muslin (or flannel) out upon a table, a thick cream of plaster of Paris is mixed in a basin. The plaster is poured upon the center part of the goods, one-eighth to one-fourth inch deep, from near one end to the other, and then one side is folded over the plaster, and the other side over this side; the plaster being covered on one side by one thickness of goods, on the other by two thicknesses. The splint is applied by grasping the muslin near each end and placing it in the position intended. It is fastened by means of a roller bandage, the upper and lower ends being turned down and up respectively and secured with the bandage. The splint soon hardens. One or several splints can be put on in this way, and to render the dressing more firm, one or two layers of a plaster bandage can be used. The bandage over the wound can be cut, allowing inspection and dressing without interfering materially with support. Everything can be taken off with pocket-case scissors in a few minutes. A plaster cast without a window soon becomes a dirty affair if there be much drainage. It is a rare exception

PLATE VI.
THE MAKING OF A WINDOW IN A PLASTER OF PARIS SPLINT.



METHOD OF APPLYING PLASTER BANDAGE.

After the application of an antiseptic dressing, a sterile metallic box (pasteboard will answer) is placed over the wound area and covered in by a plaster bandage applied so as to fix the ankle and knee joints.

PLATE VII.
THE MAKING OF A WINDOW IN A PLASTER OF PARIS SPLINT.



MAPPING OUT OF WINDOW.
The plaster bandage applied. Showing where the window is to be cut out, which must be done before the plaster is hard.

PLATE VIII.
THE MAKING OF A WINDOW IN A PLASTER OF PARIS SPLINT.



WINDOW MADE.
The window cut out and the edges molded by using a little plaster cream.

for a case to do other than well if the practice recommended is carried out. The drainage tubing is removed under antiseptic irrigation (bichloride 1:2,000) in from six to ten days, and repair progresses, but is delayed somewhat longer than in cases of simple fracture. The wound may not need dressing oftener than once every ten days or two weeks.

The More Complicated Cases.—When extensive injury to the soft parts exists the wound should be so opened and explored as to admit of thorough antiseptic cleansing, suturing of divided muscles and nerves with well selected sizes of chromic catgut, and the placing of drains so as to secure the best service. It may be wise to fasten the broken bone ends together with silver wire, heavy chromic catgut, or plates if there is great tendency to displacement, or if there is more than a little separation of the upper and lower ends because of the removal of many fragments. In this last case it may be wisest to leave the fragments rather than invite non-union, the risk of necrosis being less than non-union if a thorough antiseptics is employed. In the leg or fore-arm, if there has been a destruction of one of the bones, the other not being fractured, so as to leave a considerable space between the ends, it would be good surgery to resect or fracture the sound bone and thus admit of approximation of the widely separated ends of the injured bone; the extremity after repair would be shortened but useful.

The dressing and management of these more complicated cases is similar to that of less serious injuries just described. As a dressing an inch or two thickness of gauze and a similar thickness of cotton is necessary in all compound fractures, and as a rule the dressing should extend the length of the plaster splint.

Emphysema occurs occasionally about a compound fracture, or even extending widely over a greater or less portion of an extremity. The condition is of little importance and does not mean infection as is apt to be feared.

Infected Compound Fractures.—When compound fractures have been treated as described, they rarely give trouble from infection, but should this follow, we resort to frequent (daily or oftener) irrigations to flush out debris and prevent blocking of drains. Carbolic acid in solution 1-20 may be used occasionally instead of the bichloride solutions, and even it may be practicable and advantageous to mop out certain places with the pure acid, followed immediately by alcohol.

Perfect fixation is of the greatest importance, as tending to limit irritation and prevent spreading of the infection up and down close to the bone and between intermuscular planes.

When sepsis is checked and repair takes its place, union may progress in spite of some necrosis about the bone. This necrosis may require subsequent operation, and occasionally results in extensive matting of soft parts with deformity. Prompt antiseptic treatment and possibly incisions to better drainage will limit the infection to the soft parts and repair of the bone injury will go on undisturbed.

Joint Complications.—Nowadays, when a joint is involved in a compound fracture, we treat the joint injury exactly in the same way as we do the fracture, only our drainage of the joint should be complete, i. e., through and through, to prevent accumulations in the pockets of the joint of blood and exudate. If infection occurs we resort to fixation, antiseptic irrigation and drainage, and usually the infection can be controlled with a resulting more or less stiff joint.

Primary resection in these cases is sometimes done, but rarely needed. An atypical or partial resection may be good practice, as tending to increase the chances of a useful joint where displaced fragments can result in interference of motion or, if loose, become necrosed.

Amputation.—Amputation is only called for under two conditions: First—When the original injury causes a devitalization of the parts below the fracture. The operation should be done as soon as there is suf-

ficient reaction from shock. Second—When suppuration, necrosis, and hectic symptoms have resulted, in spite of fixation, drainage, and antisepsis, and the vitality of the patient is becoming sapped. Amputation should be done before a “successful operation,” *but* fatal termination follows.

CHAPTER XVIII.

TREATMENT OF GUNSHOT WOUNDS.

It is impossible to attempt in a single chapter to more than outline the rules to be followed in the surgical care of gun-shot wounds. The principles involved are in direct accord with those accepted by modern surgeons regarding the treatment of wounds in general. Experience has positively proven that *all* bullet wounds (with a few exceptions to be named later) are most safely treated by the antiseptic application of a primary occlusive antiseptic dressing, without preliminary, digital, or instrumental interference or exploration. The additional aid of splints is called for in wounds involving the integrity of bones and joints.

When a bullet has cut a blood-vessel and hemorrhage is going on either externally or internally, active immediate surgical relief should be attempted by an exploration sufficiently free to apply the surgical rule, viz., ligation of the wounded vessel immediately above and below the wound. Temporizing measures, such as direct compression or the use of an improvised tourniquet, may be necessary before ligatures can be used. The application of a ligature to the proximal end of a divided artery or on the proximal side and at a distance from the wound in an artery is only justifiable when the anatomical arrangement or exceptionable circumstances prevent the application of the double ligature.

The suturing or resection of arteries and veins wounded by bullets has been practiced successfully, but can scarcely be more than the dream of a military surgeon in the field. In garrison or civil hospital favorable occasions will now and then occur for this high degree of surgical practice.

Wounds of the skull, when penetrating, whether or no there be symptoms of compression of the brain, de-

mand surgical interference. First, the scalp should be shaved and the wound area most carefully prepared as for a serious operation within the skull (for example, removal of a tumor of the brain). Then, after turning back a "horseshoe flap" containing the wound through the scalp somewhere near its center, if this be feasible, the opening in the skull is enlarged sufficiently to determine as far as possible the nature and extent of the injury to the brain. Through the enlarged skull wound sometimes bone fragments are removed. The bullet ought to be extracted by following its track with a suitably shaped, dull-pointed instrument, such as a closed urethral forceps. Sharp-pointed instruments should never be used,—in fact, scarcely any kind of probe is safe,—because a false passage is apt to be made. After locating the ball (sometimes apparently impossible) it should be extracted by means of a suitable forceps; the urethral forceps is scarcely strong enough.* Girdner's telephone probe may be invaluable in determining the location of a bullet. On two occasions the writer has been able to follow the track of a ball through the brain close to the skull at a point, in one case, nearly opposite the wound of entrance; in the other, at a considerable angle below. A counter opening in each case was made and the ball extracted. Drainage should always be employed, and when a counter opening has been made, should be of the "through and through" variety, because the irritation of the examination and determining of the track of the ball might result in an inflammation, the outcome of which could in no possible way prove other than fatal without drainage.

If a ball has passed through the skull, the wounds of entrance and exit had better be enlarged, all loose fragments (*spiculæ*) removed and the case treated, not by "through and through" drainage, but by the local

* The use of the fluoroscope and the taking of radiographs are valuable aids in locating foreign metallic bodies in all parts of the anatomy. The writer succeeded in one case and failed in another to locate a bullet in the brain by means of radiographs—probably a fair average of success and failure in similar cases.

drainage of each wound, such as one would employ in any ordinary compound fracture of the skull.

Gun-shot wounds of the chest have been referred to when discussing wounds of the chest, and nothing further is necessary regarding them at this time only perhaps to emphasize the importance of non-interference in all cases except those threatening life from hemorrhage.

Wounds of the Abdomen.—When a ball enters the abdomen above the umbilicus and its course is confined above a plane passed through and at right angles to the long axis of the body at this point, non-interference is justifiable under the following circumstances: 1. The absence of symptoms denoting hemorrhage. 2. If the bullet is a small one, not larger than a number 32, especially if it is a number 22. 3. If there is an absence of the clinical symptoms pointing to leakage into the peritoneal cavity from the stomach or bowels. 4. The impossibility of securing suitable surroundings and skilled surgical experience.

When a penetrating or perforating wound of the abdomen occurs below the plane above indicated, and it is possible to employ clean methods, even though the operator may not be experienced, but appreciates the necessity and can, in a practical way, be surgically clean, no time should be lost in opening the abdomen, searching for and repairing all damage inflicted by the bullet.

When a patient who has suffered a gun-shot wound of the abdomen, no matter where the wound be located, can be offered all the essentials of a modern, properly conducted abdominal section, no time should be lost after the receipt of the injury before the operation is performed.

Gun-shot wounds involving bones and joints are of the nature of compound fractures. However, unless the wound be inflicted by a fragment of a shell, pellets from a shot-gun fired at close range, or a very large, possibly explosive bullet, the treatment to be followed is usually not that recommended for compound fractures. Ordinarily, bullets, especially those fired from

modern pistols and rifles, do not carry foreign bodies into the wound. The track of the wound is almost invariably free from germs; therefore, all digital and instrumental exploration is to be deplored, as experience has proven that these classes of injuries are followed by the least loss of life and limb by the application, after antisepticing the skin around about the wound of entrance or entrance and exit, of a primary occlusive antiseptic dressing covered by plaster of Paris or some other immobilizing splint material.

The writer's attention was first called to the advantages of this line of practice by an article published in 1883 from the pen of Dr. Raymond, United States army, detailing his experience and also that of a brother medical officer, a Dr. Ewing, United States army. Together, these gentlemen treated a number of officers and soldiers who had been wounded in engagements with Indians in Arizona in the spring and summer of 1883. The results obtained were as comparatively favorable as those of Reyher, to whom, if memory is trustworthy, Dr. Raymond referred.

Pilcher, in his recent work, quotes Reyher and says: "Out of 28 cases of gun-shot wounds of the knee, with bullet imbedded in the parts, the 4 which were treated in accordance with these principles, from the *onset*, recovered with movable joints; 8, in which antiseptic precautions were not adopted until the next day, died, as well as 4 which had no such treatment at all; while of the remaining 12 which had no primary antiseptic treatment and required either intermediate or secondary amputation, 11 died. Of 46 cases of wounds of different joints treated as above, 6 died—mortality 13 per cent.; of these 19 required primary resection, of which only 2 died—10.5 per cent. Of 78 cases, similar in other respects, but in which antisepsis was a secondary consideration, or from which bullets had been extracted, 48 died—61.5 per cent. Of another series of 62 shot wounds of joints without primary precautions, 39 died—63 per cent. So in cases of shot fracture of long bones, of 65 treated from the first, only 5 died—7.6 per cent. Of 29 not so treated, 8 died—27

per cent. In a neighboring hospital to his own during the campaign in the Caucasus Reyher saw 7 cases of uncomplicated wounds of soft parts die of pyemia; under his own primary antiseptic measures, he lost one such. In another series of 65 fractures treated secondarily by antiseptic rules, 23 died—35.3 per cent. As illustrating the reduced number of cases of pyemia, altogether of 81 cases of miscellaneous wounds treated primarily, only 5 died from blood poison—6.1 per cent; whereas, of 143 not so treated, 46 died—32.1 per cent. Of 57 various wounds of the skull, buttocks, and soft parts, all treated antiseptically from the start, not one died. Out of the 46 cases of gun-shot wounds of joints it was only necessary in 4 cases to depart from the system of primary occlusion without interference; whereas, of 75 cases of similar wounds treated by secondary antisepsis, drainage, etc., in 54 of them resections or amputations were required."

The results obtained in the treatment of our wounded in the recent war with Spain prove that Reyher's suggestion and practice may be expected to be followed by the best results in all classes of gun-shot wounds. Lacerated gun-shot wounds should be treated by the most painstaking digital and instrumental exploration and interference, such as has been suggested in the treatment of compound fractures extensive in character. These are the kind of wounds in which clothing is apt to be carried into the tissues, fascia extensively lacerated and thus conduits opened for extensive infection. When a gun-shot wound has become infected, drainage and antiseptic irrigation should be the rule. Amputation should only be resorted to when the vitality of an extremity has been destroyed or infection demands removal. Never probe a bullet wound unless the presence of the bullet in the tissues is giving rise to symptoms justifying its removal.

Since reading the paper of Dr. Raymond (some of whose wounded were personal friends or old patients), in 1883, immediately after its publication, the writer has invariably followed Reyher's practice. All kinds

of wounds have been met with and the results have almost invariably been favorable when the nature of the wound did not of itself rob the method of its virtue.

TREATMENT OF GUN-SHOT WOUNDS OF THE KIDNEY AND LIVER.

Among a number of cases of wounds examined by an American Surgeon visiting in Athens two (victims of the Græco-Turkish war) of successful termination of gun-shot wounds of the liver without operation were observed. Several like results are reported by American Surgeons at Santiago. These results bring forcibly to mind three fatal cases in the writer's practice.

The causes of death from gun-shot wounds of the liver, when non-complicated, are shock and hemorrhage, the usual mortality being about 85 per cent. When from the direction of the course taken by the bullet the indications are that a wound of the lower free border of the liver has occurred, resort should be had to abdominal section, the injury to the liver repaired, when practicable, by suture, and the abdomen closed without drainage. When the nature of the injury demands, in addition to suture, resort to tamponade, drainage, of course, must be established. If other viscera are involved the usual surgical practice in such cases should be followed. All other non-complicated gun-shot wounds of the liver should be treated by elevation of the foot of the bed, absolute rest, and the hypodermic administration of morphine. Ergotal, turpentine, and gallic acid may possibly be given with advantage, but strychnia hypodermically is imperative. Another important point is the fixation of the right side of the chest and abdomen by adhesive strips put on over the primary occlusive dressing. The adhesive plaster should be arranged so as to form a splint encircling the right half of the chest and abdomen from just under the axillary folds to a point one or two inches below the anterior superior iliac spine.

The object of treatment in these cases is to combat shock and favor the cessation of hemorrhage. The entrance of blood and bile into the peritoneal cavity is of itself comparatively free from danger, and in the cases upon which the writer has operated, although there was a considerable quantity of clotted and free blood in the abdomen, especially the right hypochondriac region, the active hemorrhage at the time of operation was not alarming, but became so and continued after the removal of the clots and the introduction of the gauze tamponade. This has so impressed itself upon me that I will hardly feel justified to again resort to such a procedure unless there is plausible evidence of injury of other viscera besides the liver.

When there is a complicating wound of the kidney, the operator should content himself with a retro-peritoneal incision, by which the wounded kidney may be explored and drainage established. If, however, this incision should disclose that probably from the nature and position of the wound in the kidney (and the patient's general condition) that a rapid intra-abdominal hemorrhage was taking place from the kidney, resort should be had to an immediate nephrectomy through a retro-peritoneal incision and free drainage provided. The leakage of a smaller or greater amount of urine into the peritoneal cavity from a wounded kidney, otherwise a healthy organ, is of small moment, and in both illustrations of complicating kidney wounds is best managed by gauze drainage through retro-peritoneal incisions.

Uncomplicated gun-shot (also stab) wounds of the kidney should be managed exactly as just recommended. There may be exceptionable instances when the trans-peritoneal route may be preferable, but even in case this may be chosen, an incision should be made in the loin for the purposes of drainage.

A suggestion as to the method of controlling rapid hemorrhage from the liver following a gun-shot wound not accessible to suture may be worth mentioning. The wound of entrance should be exposed,

resort being had to resection of one or more ribs if necessary, and through the track of the wound pass a bougie or catheter, by which means a gauze tampon or a non-perforated rubber tubing may be drawn so as to compress the whole track of the wound, and thus control the bleeding. It is only in a case of what promises to be fatal from hemorrhage that this or any other operative procedure except as indicated above is justifiable.

In my first case there was a complicating wound of the kidney. Treatment was by abdominal section, removal of clots, gauze tamponade and drainage through an incision in the loin. The patient succumbed from the continuance of the hemorrhage.

Second case. The wound was confined to the liver. Treatment was by abdominal section, removal of clots, gauze tamponade and drainage. Death from hemorrhage.

Third case. Complicating wound of the kidney. Treatment was by retro-peritoneal incision and drainage of the kidney; abdominal section, removal of clots, gauze tamponade and drainage. Death from continuance of hemorrhage.

In the first and last cases the hemorrhage from the kidney itself was trifling. The abdominal incision in all cases was at the outer side of the right rectus muscle. I feel positive that the change for the worse, in each of these cases, immediately following operation, was so marked that the intra-abdominal operation was a mistake.

Stab wounds of the liver which may or may not be perforating, according to the nature of the instrument and the position of the wound (usually, however, not perforating), are perhaps best treated by abdominal section and suture. A few cases, notably one operated upon by Dalton, of St. Louis, would indicate that this is the correct line of practice.

The position taken regarding the non-operative treatment of certain gun-shot wounds of the liver may not be in touch with the advanced ideas of the skirmishers on our line of surgical progress, but much

is being learned by American surgeons, as a result of our war with Spain, regarding the subject of gun-shot wounds, and this acquired knowledge will result in a higher conservatism; a better appreciation of the powers of nature. There are limitations for good. There are boundaries too often overstepped in our zeal to prove the "harmlessness of a surgical operation aseptically performed."

The writer suggested, when discussing gun-shot wounds of the abdomen, that "When a patient who has suffered a gun-shot wound of abdomen, no matter where the wound is located, can be surrounded by all the essentials of a modern, properly conducted abdominal section, no time should be lost after the receipt of the injury before the operation is performed." This ought to be qualified and read, "except when the wound is of the liver and uncomplicated, or probably so," then the suggestions just made ought to receive due consideration.

CHAPTER XIX.

TREATMENT OF BURNS AND FROST-BITES.

Burns vary so much, both locally and constitutionally, according to the cause, duration of the action of the cause, locality and area of the action of the cause, that it would seem well to briefly consider these points.

Uncovered parts of the face, body, and extremities (especially among those unaccustomed to outdoor life), when exposed, during hot weather, for some hours to the rays of the sun, suffer burns, usually quite superficial in character. Explosions of gases are apt to produce large burns. Burning or superheated solids and liquids cause, in the former, deep burns; in the latter, extensive burns. Of the former, metals, phosphorus, sulphur, and resinous substances; of the latter, oils and viscid solutions are the most common agents. Chemicals also cause inflammation, and in some cases destruction of the tissue in much the same way as hot or burning solids and liquids.

The fire of ordinary combustible materials,—in fact, all causes of burns are dependent in their effects upon the length of time they act on the tissues and the extent of the surfaces involved, varying from a simple reddening of a small area of skin or mucous membrane to a complete cooking or destruction of a smaller or greater part of the body.

Besides the direct effect of burns upon the external body, numerous internal congestions and inflammations may follow as complications. Among the early complications we sometimes observe congestions of the pharyngeal and laryngeal mucous membranes, usually resulting from inhalations of hot air or steam. These may be called primary complications. Later, complications are seen in congestions of the brain, lungs, and intestinal tract. The congestion of the upper part of the intestine sometimes ends in the formation of an ulcer, the well-known duodenal ulceration which, in rare instances, perforates.

The late complications are usually septic in character and are sometimes manifested by inflammations of the meninges of the brain, the pleura, the lungs, and the peritoneum. Cicatricial contractions accompanying the repair of a burn, where there has been greater or less destruction of tissue, oftentimes results in deformity and loss of function of the parts involved.

Formerly it was customary to divide burns into six degrees, but a simpler classification is better and more comprehensible. In practice we have to meet with those burns in which there is: (1.) Hyperemia (redness) and swelling. Either no vesicles are formed and repair takes place by exfoliation of the epidermis and its replacement without suppuration,—there is no scar,—or vesicles form filled with serum. The surfaces beneath the vesicles may or may not suppurate. Repair takes place with some little discoloration of the skin, but there is usually very little scar tissue formed. (2.) More or less inflamed areas, with vesications covering varying degrees of depth of skin reached by the causative agent. Sometimes the epidermis is destroyed and peels off easily, leaving a juicy, grayish surface beneath. Sometimes the tissues are dry, yellowish, or almost black. Both represent lifeless tissues. In such cases the depth of destruction depends upon the duration of the action of the cause. When due to direct action of fire, parts may become completely charred. Repair of burns of these severe kinds takes place by granulation. Sloughs form in the moderately severe and bad burns (Villeroy).

In order to formulate a line of treatment we may adopt a classification dividing burns into four degrees, viz.: (1.) Burns in which there is reddening, erythema or hyperemia. (2.) Burns in which there is a formation of vesicles or blebs, but which do not involve the cutis or true skin. (3.) Burns in which the entire depth of the skin is destroyed. (4.) Burns in which there is the formation of sloughs or in which there is charring.

Sunburns will be mentioned first, because they are usually of the least severity and yield to treatment, or get well without treatment, in a short time. The burns are superficial in character,—a simple erythema or reddening of the skin,—but are often quite painful. Burns of this character and other slight or moderate burns may be treated with a solution of soda bicarbonate or by covering the surface burned with some bland substance like carbolized vaseline, bismuth subnitrate, white lead and oil as used by painters. In an emergency flour may be thickly sprinkled over the entire burned surface.*

Burns of all other degrees, in which the tissues beneath the cuticle are exposed, are wounds, and as such must be treated. Whenever it is possible these burns should be treated antiseptically from the first. Burns are suspicious wounds always, and if antiseptic treatment is not begun at once infection and pus are always sure to follow.

Burns of the second degree are attended by the formation of blebs and vesicles, which are raised above the surrounding skin, and where the blebs are ruptured the true skin is exposed.

In the treatment of this class of burns the skin around the burn should be thoroughly scrubbed with soap, followed by alcohol and bichloride 1-1,000. Then with the thumb forceps and scissors all loose cuticle and all cuticle covering the blebs should be removed, after which the whole burn should be irrigated with 1-5,000 bichloride or 1-100 carbolic. If the surface is a large one and the pain is severe, this, as well as the completion of the dressing, may be done under an anesthetic.

Now as to the dressing. It must be remembered that whatever dressing is used it must be non-irritating, and must be such that its removal will not disturb the wound. One of the best dressings is perforated oiled silk or gutta percha tissue applied directly to the burned surface. The perforations must be more than

* A saturated solution of picric acid in water is a grateful application in all kinds of mild burns. Orthoform in powder or mixed with sterile vaseline $\frac{1}{2}$ dr. to 1 oz. is anesthetic and antiseptic.

mere slits; they must be large enough to allow free escape of serum and exudate. Over this is placed enough moist sterilized gauze to absorb the exudate, and then absorbent cotton covered with paraffine paper and a bandage. Another splendid dressing is carbolized vaseline spread upon sterilized surgeon's lint. This form of dressing is always very grateful to the patient. In severe burns of the third or fourth degree, in which there is a tendency to exuberant granulation, the oiled silk or rubber tissue is perhaps the better of the two mentioned, as it tends to keep down granulations. These two forms of dressings have at least two advantages over the dry dressings or dusting powders: First, there are never dried hard crusts of secretion next to the burn; second, the dressing is easily removed and does not have to be softened with water "peroxide," etc., before its removal is possible.

The dressings should not be removed before four or five days, unless the odor of decomposition is noticed. Where the surface burned is too large or it is not possible to follow out the antiseptic treatment given above, or when the patient is in a state of extreme shock, either from the burn or from other injuries, it is then not advisable to spend much time trying to apply an antiseptic dressing.

In those cases where the life of the patient depends upon as quick relief as possible, one of the best things at our disposal is absorbent cotton saturated with equal parts linseed oil and lime water.* This excludes the air, can be applied quickly, and thus reduces the danger from shock, the patient being almost at once put to bed and active restorative measures begun without delay. Where it is possible in these extreme cases it is best to give an anesthetic, which reduces shock and gives a better opportunity to dress the case properly; but the contra-indications to an anesthetic must be duly considered.

*The use of linseed oil and lime water ("carron oil"), flour, etc., is not in line with modern surgical therapeutics and should be allowed only in the emergencies of great shock or when better dressings cannot be secured.

What has been said of the first dressing in burns of the second degree will also apply to burns of the third degree, burns in which not only the cuticle but the cutis has been destroyed, that is, the entire skin is destroyed with or without the formation of sloughs; but the after-treatment may vary considerably. In burns of the second degree epidermization takes place without the formation of scars, leaving only a slight redness or discoloration, while in burns of the third degree, healing takes place with more or less scar formation and later cicatricial contraction.

In these burns several factors may delay very considerably the recovery. First—The burn may be and quite often does become infected. Second—The formation of extensive sloughs from deep burns, and the consequent long time for the throwing off of the slough and the filling up of its area with granulation tissue. Third—Exuberant granulations, which are soft and flabby and are raised above the edges of the surrounding skin, preventing epidermization. Fourth—The surface burned may be so large that the skin around it cannot grow over it, or else it does so very slowly.

Infected burns must be treated antiseptically and usually require dressing once a day. The pus should be disintegrated with a solution of peroxide of hydrogen, and the wound irrigated with 1-1,000 bichloride or other antiseptic solution. Care should be taken so that as little bleeding as possible is caused either by sponging or attempting to remove sloughs, as these bleeding points send the infection still deeper. In these cases Morris uses equal parts of fluid extract of ergot and warm water, squeezed from a sponge, and allowed to flow over the surface infected, and claims that profuse suppuration is sometimes cut short by one such application; giving as a reason that the ergot produces a local stimulation of the vasomotor nerve filaments, causing a condition of high tension in the blood-vessels, thus inhibiting the transmigration of leucocytes, etc. In the second condition it is often necessary to stimulate the formation of granulations.

and for this purpose stercerate of zinc, calomel, etc., may be mentioned. Exuberant granulations such as spoken of must be kept down. This is very effectually done with solid silver nitrate or else by snipping them off with sharp scissors; the former usually gives the better results.

Skin grafting plays a very important part in the treatment of burns of the third and fourth degrees and should be resorted to more often than it is. First—Burns of large areas may be made to repair in one or two weeks which otherwise would require months. Second—Cicatricial contraction may be largely prevented. Third—The repair of suppurating burns is very much hastened by grafting. The Thiersch method should be used. Grafting should begin just as soon as the granulating surface is firm, that is, when there are no flabby granulations. It is not necessary to wait until you have a wound free from pus, for I have repeatedly done skin grafting with perfect success where much pus was present. On the contrary, skin grafting always cuts short suppuration; nor is it necessary to curette the surface before grafting, as some claim. Of course the wound should be made as clean as possible. A very excellent dressing is sodium chloride and calomel, in the proportion of one of the former to four of the latter. This to be applied on the day before the grafting is done.

Before grafting, the burn should be thoroughly irrigated with strong bichloride, followed by boracic acid solution. All bleeding points should be controlled by pressure. The grafts should be applied to the granulation surface which has been sponged dry, as they adhere much better to a dry surface. The dressing is the rubber tissue, oiled silk, or else sterilized or borated vaseline. The dressing should not be removed for at least four days, unless conditions of suppuration or something else should absolutely demand it. When the grafting has been done under aseptic conditions the dressing may remain much longer.

Great care should be used always that the grafts are not disturbed when dressings are changed. If

PLATE IX.



Extensive burn under process of repair by Thiersch's method of skin-grafting. (From a patient in the Clarkson Hospital.)

only a part of the grafting can be done at one sitting, it is best to place a row of them around the edges of the wound at a little distance from the skin line. Then in a few days another set may be placed inside the first one.

In burns of the extremities of the third or fourth degree, where a portion of the extremity has been either cooked or charred, amputation is the only resource, and is to be done as soon as the patient's condition will permit.

The general treatment for the shock is the same as for shock from any other condition and has been discussed in another chapter. As mentioned above, cicatricial contractions may be to a great extent prevented by skin grafting. The complications must be treated as they are met. It must be remembered that kidney complications are almost certain to follow burns of extensive areas, and in these cases the complications should be anticipated as far as possible by proper prophylactic treatment.

In burns over large areas, even though the patient may feel pretty well, and the burn does not seem severe, the prognosis should always be carefully guarded.

A duodenal ulcer, which has perforated, would be indicated by well-recognized symptoms of intestinal perforation. An immediate operation for the closure of the perforation gives the patient the only chance for life.

Burns caused by chemicals should be treated by the immediate application (by swallowing in case of the pharynx and esophagus) to the surface involved of a chemical having an opposite reaction, and at the same time being non-irritating in itself. Burns caused by strong acids should be treated by the application of an alkaline substance, such as bicarbonate of soda or lime water. These will neutralize the excess of the acid. Vinegar or any dilute non-irritating acid may be used in case of burns by strong alkalies. Milk and the white of eggs should be given after the swallowing of either strong alkaline or acid chemicals. Whis-

key or brandy must be administered after the accidental taking of carbolic acid. Alcohol so changes the chemical action of carbolic acid as to render it practically inert in its effect upon the tissues. The stomach may be washed out with equal parts of whiskey and water or a 25 per cent. solution of alcohol in water. It prevents its absorption as carbolic acid, and even might act as an antidote to carbolic acid poisoning if given in large doses—one initial dose of two to four ounces. This may be repeated as often as indicated. The idea being to surcharge the system with alcohol, short of danger from the alcohol itself. Surface burns from chemicals require the same treatment as other burns.

TREATMENT OF FROST-BITE.

Frost-bites of exposed parts, as the ears, nose, cheeks, and fingers, need little or no attention unless the exposure has been of some considerable duration. Under such circumstances the re-establishment of active circulation in the pale, benumbed tissues is first brought about by frictions with a warm hand. As soon as it is observed that the circulation is returning, the parts may be rubbed with snow or bathed in cold water. The object in using snow or cold water being to overcome as far as possible too great dilatation of the blood-vessels in the frost-bitten parts *after* the return of the blood into their paralysed walls; also the return of the blood is gradually brought about. It is this local overdistention of the blood-vessels which permits of the clinical symptoms of inflammation. In fact it is practically impossible to prevent some redness and swelling with subsequent desquamation, but the continued local application of moist cold will tend to reduce inflammation and its consequences. An ointment of ichthyol and lanoline, one part in eight, is beneficial in the early desquamative stage. The lead and opium wash is also useful.

Severe frost-bite, threatening the vitality of the distal parts of an extremity, is a very serious affair.

It is the resultant inflammation following the return of the circulation in parts not absolutely killed by cold that ends in loss of life to the tissues,—gangrene. Stimulation and well-recognized methods for the restoration of the weakened circulation are essential. So soon as any existing dangerous general depression is relieved and the heart tone restored, then the frost-bitten parts should be thawed out by using cold water and frictions.

Even in the homes of the very poor cold water may be made to drip upon the extremity from a suspended bucket, using most any material for the capillary drain. The patient's bed can be kept dry by a suitably arranged rubber sheet or table cover oil-cloth, the waste water draining into a vessel placed upon the floor by the side of the bed. This method of keeping up the continued use of wet cold is quite as effective as any of the more elegant means employed in hospital practice. The cold water should be used until the inflammatory symptoms subside or until by the formation of a line of demarcation nature points out where life ceases and death begins. Any antiseptic can be dissolved in the cold water, perhaps bichloride of mercury 1-5,000 is the best for general use. After the line of demarcation is formed hot fomentations or hot antiseptic poultices are useful to hasten the separation of the dead from the living parts.

When gangrene has developed, but it is uncertain to what place it will extend, the writer likes to use Labarraque's solution in the cold water, of the strength of one or two ounces to the gallon. This solution is both antiseptic and deodorant. Except in gangrene of a whole hand or foot no typical amputation should be done. Dead fingers and toes are best removed by dividing the bones with forceps and allowing the ends to granulate. Judicious skin grafting may do away with amputations of major parts of the hands and feet, likewise this practice will shorten convalescence. When an amputation of a smaller or greater part of a foot is required the whole mechan-

ism, so far as its bony frame is concerned, should be treated as one bone. No attempt at fashioning flaps after the methods of the text-books should be made. The bones should be divided just above the points where they are unprotected by the granulating soft parts. By painstaking care of the granulating surfaces and the use of Thiersch's flaps good servicable stumps can be secured with the sacrifice of the smallest amount of tissue.

The impressions of an early experience in my professional career may be related with profit. In the winter of 1881-2, while the writer was connected with the army, two soldiers whose feet were badly frost-bitten were brought to the post hospital. These men were members of a hunting party. The felt boots which they wore had become wet during the day while walking through the melting snow. In the excitement of killing and butchering a buffalo just before dark they were ignorant of the changing temperature and the freezing of their feet and legs until camp was reached. Foolishly the frozen parts were first thawed out by the fire, they were then wrapped in blankets and the men sent to the hospital, where they arrived a few hours later. On admission the feet were swollen and of a ripe black-cherry color, the legs to the upper parts of the middle thirds were of a dark red color. Numerous bullæ had formed containing a prune juice colored serum. Wet antiseptic dressings were applied, over which cotton was wrapped. During the first twenty-four hours it looked as if nothing would stop the threatening gangrene and that the result would be a loss for both men of their feet with the lower thirds of their legs. Cold water dressings were then begun, and a change for the better was soon noticeable. The cases resulted in each man having one foot removed at the medio-tarsal joint and the other about one and one-fourth inches below this line. Numerous opportunities for observing similar or even worse cases have since fallen to my lot, and in many instances I have been able to save, by the continued use of wet cold, parts

that by any other treatment would have surely been sacrificed. If extremities which have been severely frost-bitten, but whose vitality is not absolutely destroyed, are seen within a reasonable time after the exposure, there ought not, as a rule, to be a greater loss to the sufferer than parts of one or several phalanges.

CHAPTER XX.

USE OF RUBBER GAUNTLETS OR GLOVES.

Numerous ways of washing the hands by surgeons, assistants, and nurses have been recommended. Some of these methods, if done intelligently and conscientiously, are supposedly reliable, others are less reliable. When not safeguarded all are objectionable, because they have to include in their carrying out the personal equation of the individual. If the most experienced, worthy, and reliable may forget at the critical moment, when of all others he should remember, what must be expected of the one recognized by the courts, the one of ordinary skill and intelligence!

Greater still than the dangers of infecting wounds by the surgeon, who uses ordinary diligence and skill, is the danger of infecting women after childbirth or abortion by the attending physician and nurse. The nature of the general practitioner's calling; treating all kinds of disease; coming and going at all hours; occasionally, because of necessity or preference, doing "chores" about the barn, house, and office,—all this leads to a weaning away from the practice of ideal surgical cleanliness on his part, both as physician and surgeon. Besides it takes daily painstaking practice to successfully learn *how to be* surgically clean.

Let it be granted, for the sake of argument, that a physician in attendance upon the general run of cases, such as pneumonitis, pleuritis, typhoid fever, diarrhea, headache, indigestion, constipation, and such like ailments, is practically free from the danger of conveying these ailments to other patients. Can the same be said of all forms of ulceration, abscess, phlegmonous inflammations, erysipelas, tetanus, puerperal sepsis, diphtheria, scarlet fever, etc.?

I know that no physician would willingly cause unnecessary suffering and danger to those who have given him their confidence and placed their health and

lives in his keeping, and it is in this spirit that I urge the habitual use of sterilized rubber gloves or gauntlets, after cleansing the hands by some good method, in every case where one's intelligence points out the advantage to the patient. *It should be the rule* (1) in obstetric practice; (2) in operating upon all forms of septic cases; (3) in the examination and treatment of all forms of septic, infectious diseases, such as erysipelas, septicemia, and pyemia, in which the hands come in contact with primary and secondary foci of infection—and this rule applies to the nurse also; (4) in operating upon *clean* cases soon after operations done upon infected ones; (5) in the examination of fresh wounds after recent examinations of, or operations upon, dirty cases; (6) in abdominal sections following vaginal operations upon the same individual—this may be reversed, wearing the gloves during the vaginal work, taking the gloves off or donning a fresh pair before beginning the abdominal work; (7) in all forms of rectal surgery.

It is a matter of choice under other circumstances whether or no gloves be worn. However, there is no question but that there is less danger of infection where gloves are worn than when reliance is placed in an attempted sterilization of the naked hands.

An impervious cotton glove is perhaps quite as good as the rubber article. The ordinary cotton glove is not safe. During the time I have been using rubber gauntlets in my work I know that my results have been more gratifying than formerly. My work has covered a very broad field. The cavities of the skull, spinal canal, thorax, and abdomen have been invaded, besides many operations of election and emergency upon the neck, trunk, and extremities have been done, a sufficient experience to base an opinion upon, and my cases have been freer from all kinds of infection than ever before. Every surgeon who is in the habit of doing a great amount of surgical work, if honest, will confess that suppuration occasionally occurs in his practice where least expected; it has done so in

mine. If the wearing of sterile rubber gloves will lessen the danger of infection, we should wear them. Occasionally I have felt compelled to take off the gloves in order to carry out some technique more satisfactorily, but such acts seldom occur now. There is little difference in tactile sensibility between the naked fingers and those covered with a well-fitted, good-articled rubber glove. The advantages outweigh the possible, in rare instances, lessened tactile acuteness. One dozen pairs of the best quality can be bought for \$15. Sterilized glycerine may be used to lubricate the hands before drawing on the gloves. A glove that cannot be reasonably easily drawn over the hand after filling the glove with sterile water is too small. Vaseline or grease ruins the rubber. The gloves should be either boiled or wrapped in a towel and placed in a steam sterilizer. Lastly, rubber gloves are a protection to the physician and surgeon against infection.

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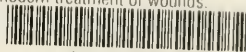
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